TOHOPEKALIGA WATER AUTHORITY
CYPRESS LAKE WELLFIELD EXPLORATORY TEST WELL
AQUIFER PERFORMANCE TESTING REPORT

Prepared for

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EXECUTIVE SUMMARY

The Tohopekaliga Water Authority (Toho) is committed to finding and developing alternative sources of water within their service area to meet future demand, while minimizing potential impacts of groundwater pumpage by redistributing pumpage to less sensitive areas of their water service area. As one step in realizing that goal, Toho authorized Tetra Tech to investigate aquifer hydraulic properties and groundwater quality in a portion of central Osceola County. The first test location is located east of Cypress Lake near Canoe Creek Road with the goal to identify alternative sources; Toho specified that the aquifer testing project should determine water quality and aquifer hydraulic parameters in potential producing zones in the lower Floridan aquifer. The project should also produce data sufficient for local refinement or confirmation of calibration of a regional groundwater flow model that will be used to design and permit an alternative water supply wellfield.

This report documents the construction and testing of four wells constructed into the lower Floridan aquifer and one monitor well constructed into the upper Floridan aquifer to evaluate the aquifer hydraulic properties of the lower Floridan aquifer east of Cypress Lake. It also provides documentation of an aquifer performance test in the upper Floridan aquifer at the same location.

Overall, the testing program consisted of:

- Construction and logging of an upper Floridan aquifer observation well;
- Construction and logging of a lower Floridan aquifer test production well;
- Construction and logging of a lower Floridan aquifer exploratory well;
- Conversion of the lower Floridan exploratory well to a dual-zone monitor well completed in the lower Floridan aquifer production zone and in the underlying confining unit;
- Sampling and analysis of groundwater during drilling;
- Sampling and analysis of groundwater from selected intervals during interval packer testing;

- Construction and logging of two additional lower Floridan aquifer production zone observation wells;

- Execution and analysis of constant rate discharge tests in the upper Floridan aquifer and in the lower Floridan aquifer;

- Construction of four surficial aquifer monitor wells.

The testing program was conducted in two phases to allow measurement of important aquifer hydraulic properties from the upper Floridan aquifer, the overlying intermediate confining unit, the underlying middle semi-confining unit or mid-Floridan confining unit, the lower Floridan aquifer, and the lower confining unit.

The construction and testing of the wells at the project site provided hydrogeologic data that was previously unavailable for this portion of Osceola County. Information obtained from construction and testing of the wells at the project site consisted of the following:

- The top of the Floridan aquifer system was identified at a depth of 240 feet below land surface at the Cypress Lake site.

- Aquifer performance testing, lithologic logs, geophysical logs, and borehole video logs provided evidence that the upper Floridan aquifer at the project site, occurring from 240 feet to 640 feet below land surface, had good production capacity with correspondingly high values of specific capacity and transmissivity. Specific capacity values range from 80 to 109 gallons per minute per foot of drawdown (gpm/ft) at pumping rates between 1,370 and 2,770 gpm and with measured drawdown between 12.60 to 34.71 feet, respectively.

- Transmissivity values of the upper Floridan aquifer were calculated to be between 42,000 and 67,000 ft^2/day, storativity values were calculated to be between 0.00004 and 0.0028 and leakance values to be between 0.0024 and 0.0029 ft/day/ft.

- The top of the middle semi-confining unit was identified at a depth of 640 feet below land surface.

- The lower Floridan aquifer was identified through lithologic and geophysical logs at a depth of 1,020 feet below land surface, and extended to the deepest pilot hole boring at a depth of 2,602 feet below land surface (with the "boulder zone" present from 2,060 to 2,100 feet below land surface). Aquifer performance testing, lithologic logs, geophysical logs, and borehole video logs indicate that the production zone of the lower Floridan aquifer at the project site (1,020 to 1,500 feet below land surface) showed very good production capacity with correspondingly high values of specific capacity and transmissivity. Specific capacity testing showed values ranged from 112.8 gpm/ft at 1,655 gpm to 87.8 gpm/ft at 3,073 gpm.

- At a discharge of 2,057 gpm at the new test/production well (TPW-1), drawdown was measured in observation wells at 500 and 1,000 feet away. These values were approximately 1.09 and 0.53 feet, respectively.

- The arithmetic mean or average lower Floridan aquifer transmissivity calculated from all of the analyses is approximately 138,000 ft^2/day and the geometric mean is approximately 130,000 ft^2/day. The arithmetic mean storativity calculated for all of the analyses is 0.0007 and the geometric mean is 0.0003. The arithmetic mean leakance calculated using the Hantush-Jacob method is 0.003ft/day/ft and the geometric mean is also 0.003 ft/day/ft.

- Drawdown in the lower confining unit at the dual zone monitor well stabilized at less than approximately 0.038 feet during the 14-day constant rate discharge test. The ratio of drawdown in the lower confining unit to the drawdown in the lower Floridan aquifer suggests that the vertical hydraulic conductivity of the lower confining unit is very low and that the potential for vertical intrusion of saline groundwater is slight.

- Drawdown in the upper Floridan aquifer at well UFMW-1 equilibrated at approximately 0.21 feet during the 14-day constant rate discharge test. The ratio of drawdown in the upper Floridan aquifer to the drawdown in the lower Floridan aquifer suggests that the vertical hydraulic conductivity of the middle semi-confining unit is moderate to low. The ratio of drawdown in the lower confining unit to drawdown in the upper Floridan aquifer indicates that during long-term pumping, leakage into the production interval will be predominantly from the upper Floridan aquifer rather than from the lower (saline) portions of the lower Floridan aquifer.

- Based upon the results of the upper and lower Floridan aquifer testing and water quality analyses, a production rate of 3 million gallons per day per production well is feasible.

- High specific capacity and apparent yield suggest the site is suitable for investigation of an alternative water supply wellfield using a groundwater flow model.

SECTION 1
INTRODUCTION

1.1 General

The Tohopekaliga Water Authority (Toho) is committed to finding and developing alternative sources of water within their service area in order to meet future demand, while minimizing potential impacts of groundwater pumpage by redistributing pumpage to less sensitive areas of their water service area. As one step in realizing that goal, Toho authorized Tetra Tech to investigate aquifer hydraulic properties and groundwater quality in a portion of central Osceola County. The first test location is located east of Cypress Lake near Canoe Creek Road (**Figure 1-1**). With the goal to identify alternative sources, Toho specified that the aquifer testing project should determine water quality and aquifer hydraulic parameters in potential producing zones in the lower Floridan aquifer. A second goal was to produce data sufficient for local refinement of calibration or confirmation of calibration of a regional groundwater flow model that will be used to design and permit an alternative water supply (AWS) wellfield.

This report presents the results of aquifer performance and water quality testing at the Cypress Lake site. Additional interpretations of the testing data will result from simulations of the tests using a MODFLOW groundwater flow model. Those interpretations will be presented in a subsequent report that presents the results of simulations of potential impacts of an alternative water supply wellfield.

1.2 Project Scope

Tetra Tech designed and executed the aquifer testing program. Overall, the testing program consisted of:

- Construction and logging of an upper Floridan aquifer observation well;

- Construction and logging of a test/production well;

LEGEND

Source: NGS USA Topographic Maps

- Monitor Well Location
- Test Production Well Location
- Regional Observation Well

N

0 6 Miles

TETRA TECH

CYPRESS LAKE WELLFIELD LOCATION MAP
TOHOPEKALIGA WATER AUTHORITY
CYPRESS LAKE WELLFIELD EXPLORATORY TEST WELLS
AQUIFER PERFORMANCE TESTING REPORT

FIGURE 1-1

TT8.5X11P_EX3535\GIS\TohoWaterAuth\9500760085\maps\CypressLake_APWSF1-1.mxd [09-30-08 ham]

- Construction and logging of a lower Floridan aquifer exploratory well

- Conversion of the lower Floridan exploratory well to a dual-zone monitor well completed in the lower Floridan aquifer production zone and in the underlying confining unit;

- Sampling and analysis of groundwater during drilling;

- Sampling and analysis of groundwater from selected intervals during interval packer testing;

- Construction and logging of two additional lower Floridan aquifer production zone observation wells;

- Execution and analysis of a constant rate discharge tests in the upper Floridan aquifer and in the lower Floridan aquifer;

- Construction of four surficial aquifer monitor wells.

The testing program was conducted in two phases to allow measurement of important aquifer hydraulic properties from the upper Floridan aquifer (UFA), the overlying intermediate confining unit (ICU), the underlying middle semi-confining unit (MSCU), the lower Floridan aquifer (LFA), and the lower confining unit (LCU). Formation picks and hydrostratigraphy were determined by inspection of drilling cuttings, geophysical logs, and video logs. The testing program was designed to measure the hydraulic properties of the LFA by conducting two constant rate discharge tests (CRDT). The upper Floridan test would produce properties for the UFA including a total leakance. Because the ICU was expected to have low leakance based on the substantial thickness and small values of vertical permeability of the units, the leakance measured during the UFA constant rate test was expected to represent leakance of the MCU, that is, the leakance between the UFA and LFA. The CRDT of the LFA would again allow calculation of the properties of the LFA and a total leakance for the LFA. In that test, leakance of the LCU (between the lower intervals of the LFA and the production zone) could be estimated from the head response in the lower interval of the dual zone monitor well (DZMW-1).

1.3 Acknowledgements

Tetra Tech and the Toho Water Authority would like to acknowledge the funding assistance of the South Florida Water Management District (SFWMD) and the cooperation of the Bronson Family who allowed access to their property for drilling and aquifer testing.

SECTION 2
WELL CONSTRUCTION AND TESTING

2.1 Introduction

This section of the report summarizes the construction and testing of wells constructed at the site during this project. Detailed well construction summary reports prepared by Ardaman and Associates (a Tetra Tech Company) are provided in **Appendices A.1** through **A.5**. Construction began with the upper Floridan monitor well (UFMW-1) on May 16, 2007. Well UFMW-1 was constructed with 6-inch inside diameter steel (ID) casing to a depth of 300 feet below land surface (BLS) and the open borehole was drilled to a total depth of 600 feet BLS. Drill stem water quality samples were collected at intervals of 40 feet from 340 to 600 feet BLS and were delivered for laboratory analysis.

This well was constructed first to provide a water source for construction of the remaining onsite monitor wells and the original test/production well (TPW), and to provide an observation well in the upper Floridan aquifer (UFA) during aquifer performance testing (APT). Upon completion of well UFWM-1, construction at well TPW was initiated on June 18, 2007. Well TPW was constructed with 30-inch outside diameter (OD) surface casing to a depth of 252 feet BLS, and the open borehole was drilled to a depth of 600 feet BLS. Construction at well TPW was suspended to conduct a 72-hour constant rate discharge test (CRDT) to determine the aquifer parameters in the upper Floridan aquifer at the Cypress Lake site. Prior to completing well TPW to the designed total depth of 600 feet BLS, construction was initiated at the nearest lower Floridan monitor well (LFMW-1) on August 2, 2007. Construction commenced at the second lower Floridan monitor well (LFMW-2), located approximately 500 feet from the test production well, on August 21, 2007, and at the most distant lower Floridan aquifer monitor well (LFMW-3) on October 15, 2007. A 72-hour UFA CRDT was conducted from October 16 through October 19, 2007 with well TPW pumping at an average discharge of 1,900 gallon per minute (gpm). Response in the upper Floridan aquifer was monitored in wells UFMW-1, LFMW-2 (completed to a total depth of 600 feet BLS for the UFA CRDT), and several surficial aquifer wells. Drawdown was also observed in an off-site SFWMD well, OSF-62, but those data were used only in model-based evaluations and are not reported herein.

By the end of November 2007 construction on the unfinished monitor wells (LFMW-2, LFMW-3) and well TPW was temporarily suspended until the pilot hole at LFMW-1 was completed to a depth of 2,600 feet BLS, and geophysical logging was conducted, in the pilot hole, to ensure that final casing depths were accurately chosen. During drilling of the pilot-hole, drill stem water quality samples were collected every 40 feet (600 to 2,600 feet BLS) and submitted for laboratory analysis; drilling was completed at well LFMW-1 on December 19, 2007, followed by the geophysical logging, which was completed before the end of the year. Construction resumed at well LFMW-2 on January 3, 2008 and was completed with the installation of an 8-inch ID steel casing to a depth of 1,020 feet BLS. The open borehole of well LFMW-2 was completed to a total depth of 1,500 feet BLS. Construction resumed at well LFMW-3 on February 19, 2008 and was completed with the installation of an 8-inch ID steel casing to a depth of 1,020 feet BLS and drilling of the open borehole to a total depth of 1,500 feet BLS.

Back-plugging of the 8-inch nominal diameter (ND) pilot hole at well LFMW-1 from 2,602 to 1,841 feet BLS was conducted from March 18 through March 26, 2008. Instead of using well LFMW-1 as a single-zone monitoring well in the production zone, Tetra Tech recommended the conversion of this well to a dual-zone monitor well (DZMW-1) to monitor the production zone and to include monitoring of a lower portion of the LFA (below the production zone). Two intervals were monitored during the LFA CRDT, to measure the contrast in head response and thereby to estimate the potential for upconing of brackish water at the site. The lower monitoring zone (1,841 to 1,800 feet BLS) comprises the interval between the bottom of the 3-inch ID steel casing and the 8-inch ND borehole remaining open after back plugging. The upper monitoring zone (1,020 to 1,500 feet BLS) comprises the interval between the bottom of the 8-inch ID steel casing at a depth of 1,020 feet BLS and the top of the annular grout for the 3-inch ID inner casing.

Construction resumed at well TPW by reaming the borehole to a depth of 600 feet BLS to set the 24-inch diameter steel intermediate casing. Several unsuccessful attempts were made by the Contractor (Rowe Drilling Company) to properly install the intermediate casing at well TPW. The contractor abandoned construction of well TPW due to a serious deviation in the casing or open-hole interval. On May 12, 2008 construction began at the new location (approximately 35 feet northwest of the original well TPW) for the new test/production well (designated TPW-1) and was completed with the installation of 17.4-inch diameter SDR Certa-Lok casing to a depth of 1,020 feet BLS, and a nominal 15-inch diameter borehole to a total depth of 1,500 feet BLS.

Since a majority of the onsite testing was conducted at well LFMW-1 (DZMW-1), details of the construction and testing are summarized, herein, and included in total as **Appendix A.1**. Additional reports summarizing the construction and testing of the onsite monitor wells mentioned above (UFMW-1, LFMW-2, and LFMW-3) and TPW-1, including a report on the upper Floridan aquifer performance testing is provided in **Appendices A.2** through **A.6**.

2.2 Well Construction and Testing Summary at LFMW-1

Well construction of well LFMW-1 began on August 2, 2007 with the advancement of the 12.25-inch pilot hole for the pit casing to a depth of 40 feet BLS, and was followed by reaming of the borehole using a 30-inch diameter drill bit. Installation and grouting of the 26-inch OD steel pit casing to a depth of 40 feet BLS was completed using approximately 40 sacks of neat cement. Drilling of the pilot hole was continued using the mud rotary method to a depth of 300 feet BLS, followed by reaming of the borehole using a 26-inch diameter drill bit to a depth of 235 feet BLS, until circulation of the drilling fluids was lost. Fluid circulation was restored by grouting the bottom of the open borehole to plug a void in the limestone. Grouting of the void required approximately 2 cubic yards of neat cement grout. Circulation of the drilling fluid resumed, enabling the reaming of the borehole to a total depth of 272 feet BLS. The 20-inch OD steel surface casing was set at a depth of 270 feet BLS and grouting was completed using approximately 30.2 cubic yards of neat and 2% bentonite cement and 0.8 cubic yards of gravel. Pilot-hole drilling continued using the mud-rotary method until the borehole appeared to produce sufficient water to support reverse-air drilling. The driller switched from the mud-rotary method to the reverse air method at 305 feet BLS, and reverse-air drilling continued to a depth of 610 feet BLS. The borehole was reamed using a 19-inch diameter drill bit to a depth of 603 feet BLS. The 14-inch ID steel intermediate casing was set at a depth of 600 feet BLS and grouting was completed using approximately 31 cubic yards of neat cement and 2% bentonite cement grout and approximately 5 cubic yards of gravel. Pilot-hole drilling continued using a 12.25-inch diameter drill bit to a depth of 1,303 feet BLS, and an 8-inch diameter drill bit was used for the remainder of the pilot-hole. The total depth of 2,602 feet BLS was reached on December 19, 2007.

Geophysical and video logging was conducted in the pilot hole from 600 to 2,600 feet BLS. Back plugging of the 8-inch ND pilot hole from 2,602 to 1,841 feet BLS was conducted from March 18 through March 26, 2008. Construction of the upper monitoring zone (1,020 to 1,500 feet BLS) was initiated when the 8-inch ID steel casing was installed to a depth of 1,020 feet BLS.

Development of the interval from 1841 feet to 1020 feet BLS was conducted for a period of 10.5 hours until the final field turbidity was below 1 NTU (0.78 NTU measured). The final sand content was 5.3 ppm. On April 8, 2008 a step drawdown test of the interval from 1841 feet to 1020 feet BLS was conducted at well LFMW-1. The step-drawdown test consisted of pumping the well at four increasing rates of 217, 300, 400, and 495 gallons per minute (gpm). Estimated the interval specific capacity at 163.2 gpm/ft, 120.0 gpm/ft, 101.3 gpm/ft and 87.8 gpm/ft at pumping rates of 217, 300, 400, and 495 gpm. We calculated well efficiencies using the Hantush-Bierschenk method between 39.86% at 495 gpm and 76.62% at 217 gpm, respectively.

The lower monitoring zone (1,841 to 1,800 feet BLS) comprises a 3-inch inside diameter steel casing grouted in to the existing 8- and 12.25-inch nominal diameter borehole using a cement (Halliburton) basket. The 3-inch casing is centered in the 8-inch inside diameter casing using welded centralizers and is grouted in place from 1,800 feet to 1,500 feet BLS. The 3-inch casing is not centered in the upper 1,020 feet so that adequate access is available to install a 4-inch diameter pump into the annular monitoring zone that comprises the upper monitoring interval.

2.2.1 Geology and Hydrogeology

In this report, and during this project, we employ commonly used terminology for the aquifers and confining beds of the Floridan aquifer system (FAS) and overlying units. Descriptions in the literature are varied, and to some extent, are colloquial. Descriptions of these units and their component geologic formations as we used them in this report are summarized below.

The surficial aquifer system (SAS) comprises reworked and primarily siliciclastic marine sediments. Groundwater from the SAS is not generally used for large irrigation or public supply uses, but it is a source for small irrigation systems and domestic self-supply wells. The intermediate confining unit (ICU) comprises, primarily, upper Miocene to Pliocene Series clay-rich sediments with most of the ICU confining beds being of the Miocene Series. Some intervals within ICU may be locally used for domestic self-supply and irrigation. Neither the SAS nor the ICU is a significant source of water in the vicinity of the Cypress Lake test site.

In contrast, the UFA is a very important source of water for irrigation, public supply (Toho Water Authority and the City of St. Cloud system, for example), commercial/industrial supply and domestic self supply. The UFA comprises the permeable and highly productive portions of the Ocala Limestone (Late Eocene Series) and Avon Park Formation (Middle Eocene Series). Permeability within the UFA is significantly high and is enhanced by flow through secondary porosity features such as cavities and conduits in the Ocala Limestone and fractures and conduits in the Avon Park Formation.

The UFA is bounded below by the less permeable middle semi-confining unit (MSCU). The MSCU at Cypress Lake consists of a series of lower permeability beds of limestone and thin resistant beds of dolomite alternating with porous and permeable intervals. The MSCU was not observed as a single thick unit of lower permeability rocks at this location. This interpretation of a semi-confining unit (MSCU) was borne-out by the results of constant rate discharge tests in the UFA and in the LFA.

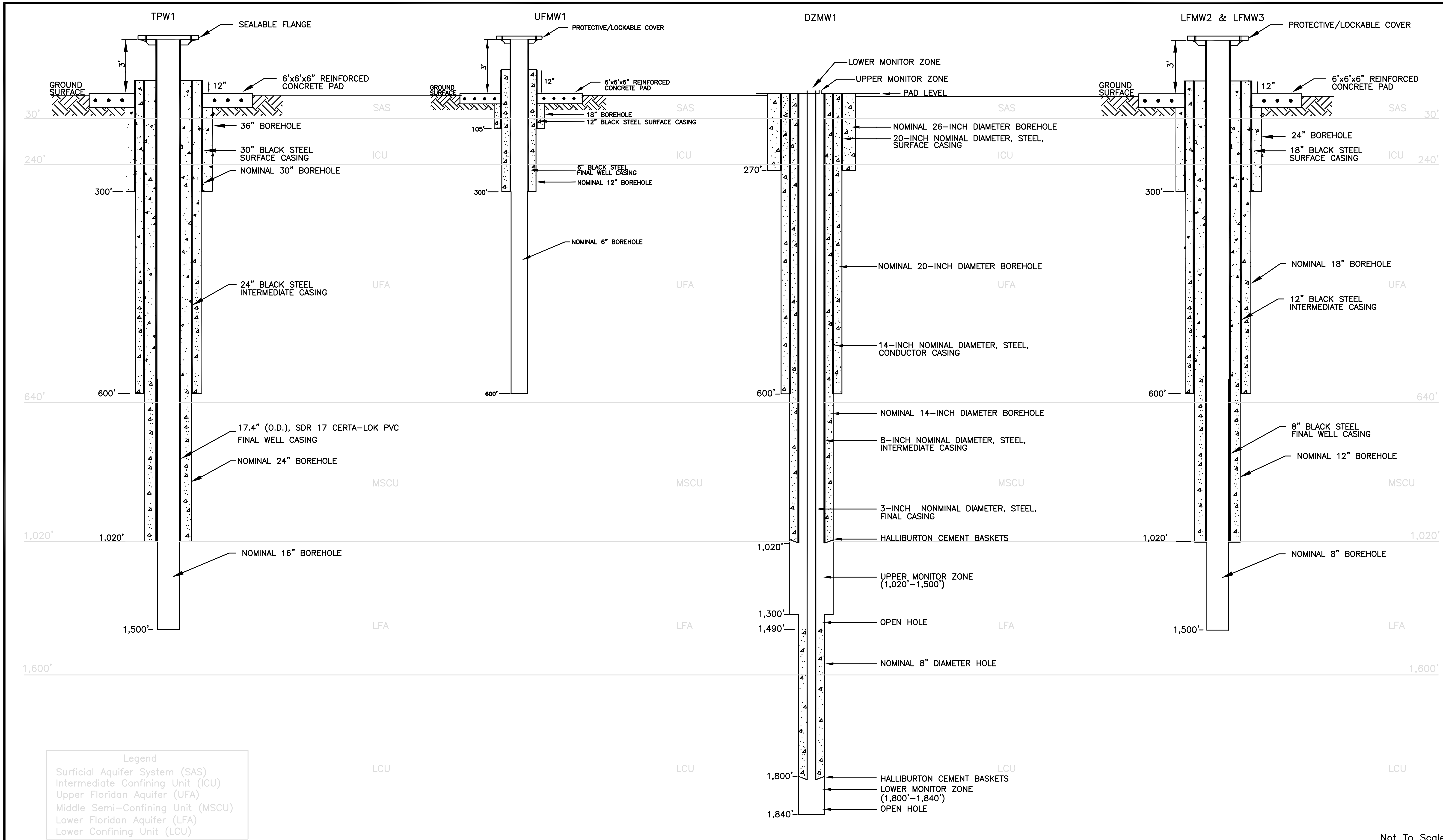
A very permeable and productive interval of the Avon Park Formation occurs below the MSCU in an interval between approximately 950 and 1,250 feet BLS. This interval is described as the "Avon Park producing zone" within the upper portion of the LFA. This definition is similar to the AECOM Water Investigation (2008) which identified a similar position in the MSCU at the SFWMD's monitoring wells OKF-10 and OKF-105 and similar with Gates (2006) who identified a similar position for the top of the LFA at Southwest Florida Water Management District's (SWFWMD) monitoring well ROMP 74X in Davenport, Florida. Many references, such as the USGS Professional Paper 1403-C (Bush and Johnson, 1988) segregate the FAS into an upper unit (UFA), a middle confining or semi-confining unit (MSCU) and a lower unit (LFA). In their definition, and others, the top of the LFA coincides with the base of the MSCU. Other interpretations are possible. The permeable zone between roughly -950 and -1,200 feet NGVD is also referred to as "middle Floridan aquifer" by the USGS and South Florida Water Management District (SFWMD) (Reese and Richardson, 2008).

Additional confining beds and permeable intervals of the LFA system were observed in the test borings. One other colloquially named interval, the "boulder zone", was noted as several intervals of cavernous porosity and large fractures between approximately 2,060 and 2,100 feet BLS. The "boulder zone" was separated from the "Avon Park producing zone" by several hundred feet of lower permeability rocks. For convenience, the confining beds between the "Avon Park producing zone" and the "boulder zone" are referred to as the lower confining unit (LCU) because it represents the base of potable or brackish groundwater. The total dissolved solids concentration of groundwater in the "boulder zone" and below is nearly that of seawater. The lower portions of the LFA system contained beds and nodules or cavity fill (based on their appearance in the borehole video) and appear to be of low permeability. It may comprise a portion of the LCU of the FAS.

A brief summary of the lithologic samples at LFMW-1 are as follows: Undifferentiated surficial soils consisting of slightly silty to silty sand from land surface to a depth of 30 feet BLS. A clay, consisting of slightly clayey to clayey sand and clay, occurs from 30 to 130 feet BLS. The Hawthorn Group occurs from 130 to 240 feet BLS. The Peace River Formation of the Upper Miocene Hawthorn Group consisting of interbedded quartz sands, clayey sand, and carbonates occurs from 130 to 194 feet BLS; while the undifferentiated Arcadia Formation of the Hawthorn Group consisting of interbedded granular and fine grained limestone and clay, occurs from 194 to 240 feet BLS. The carbonate units of the Upper Eocene Ocala Limestone, consisting of interbedded granular and fine grained limestones, occur from 240 to 350 feet BLS. The Middle Eocene Avon Park Formation, consisting of interbedded granular and fine grained limestones, dolomitic limestone and crystalline dolomite (dolostone), occurs from 350 to 1,780 feet BLS. The Lower Eocene Oldsmar Formation, consisting of alternating beds of porous limestone, dolomitic limestone, and crystalline dolomite occurs in the borehole from 1,780 to 2,602 feet BLS.

The hydrostratigraphic units encountered during the advancement of the pilot hole included the SAS from land surface to 30 feet BLS, the ICU from 30 to 240 feet BLS, the UFA from 240 to 640 feet BLS, the MSCU from 640 to 1,020 feet BLS and the LFA from 1,020 to 1,600 feet BLS, and the LCU from 1,600 to 2,600 feet BLS (with a "boulder zone" encountered from 2,060 to 2,100 feet BLS).

Figure 2-1 shows the construction details of each well (TPW-1, UFMW-1, DZMW-1, LFMW-2 and LFMW-3) and the corresponding hydrostratigraphic units they intercept.



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OBSERVATION WELL SPECIFICATIONS

FIGURE 2-1

2.2.2 LFMW-1 Drill Stem Water Quality

From October 2007 through December 2007 the 12.25-inch and 8-inch pilot hole was drilled from 600 to 2,602 feet BLS at LFMW-1. During this time drill stem water quality samples were collected at 40-foot intervals and submitted to Florida Analytical, Inc. for laboratory analysis of inorganic parameters. The parameters tested were pH, temperature, turbidity, specific conductance, TDS, chloride, hardness, iron, sulfide, and sulfate. Drill stem water quality samples were collected in conjunction with the geophysical and lithologic logs to determine intervals for packer testing at LFMW-1.

Significant water quality changes were identified at three different depths during the pilot hole drilling at LFMW-1. The analytes that showed a spike in water quality with depth were conductivity, TDS, chloride and sulfate. At 1,600 feet BLS conductivity was 1,392 µmhos/cm, TDS was 88 mg/L, chloride was 393 mg/L and sulfate was 91.2 mg/L. At 1,900 feet BLS conductivity was 2,800 µmhos/cm, TDS was 1,936 mg/L, chloride was 968 mg/L and sulfate was 201 mg/L. At 2,200 feet BLS conductivity was 42,400 µmhos/cm, TDS was 32,700 mg/L, chloride was 18,420 mg/L and sulfate was 2,960 mg/L. During the pilot hole drilling the conductivity ranged from 251 to 51,700 µmhos/cm, TDS ranged from 88 to 34,600 mg/L, chloride ranged from 11.6 to 19,200 mg/L, and sulfate ranged from 17.5 to 2,960 mg/L. Provided in **Table 2-1** are the drill stem water quality results and **Figure 2-2** shows a graph of the drill stem water quality for the analytes discussed above at LFMW-1 from 600 to 2,600 feet BLS.

2.2.3 Borehole Geophysical and Video Logging

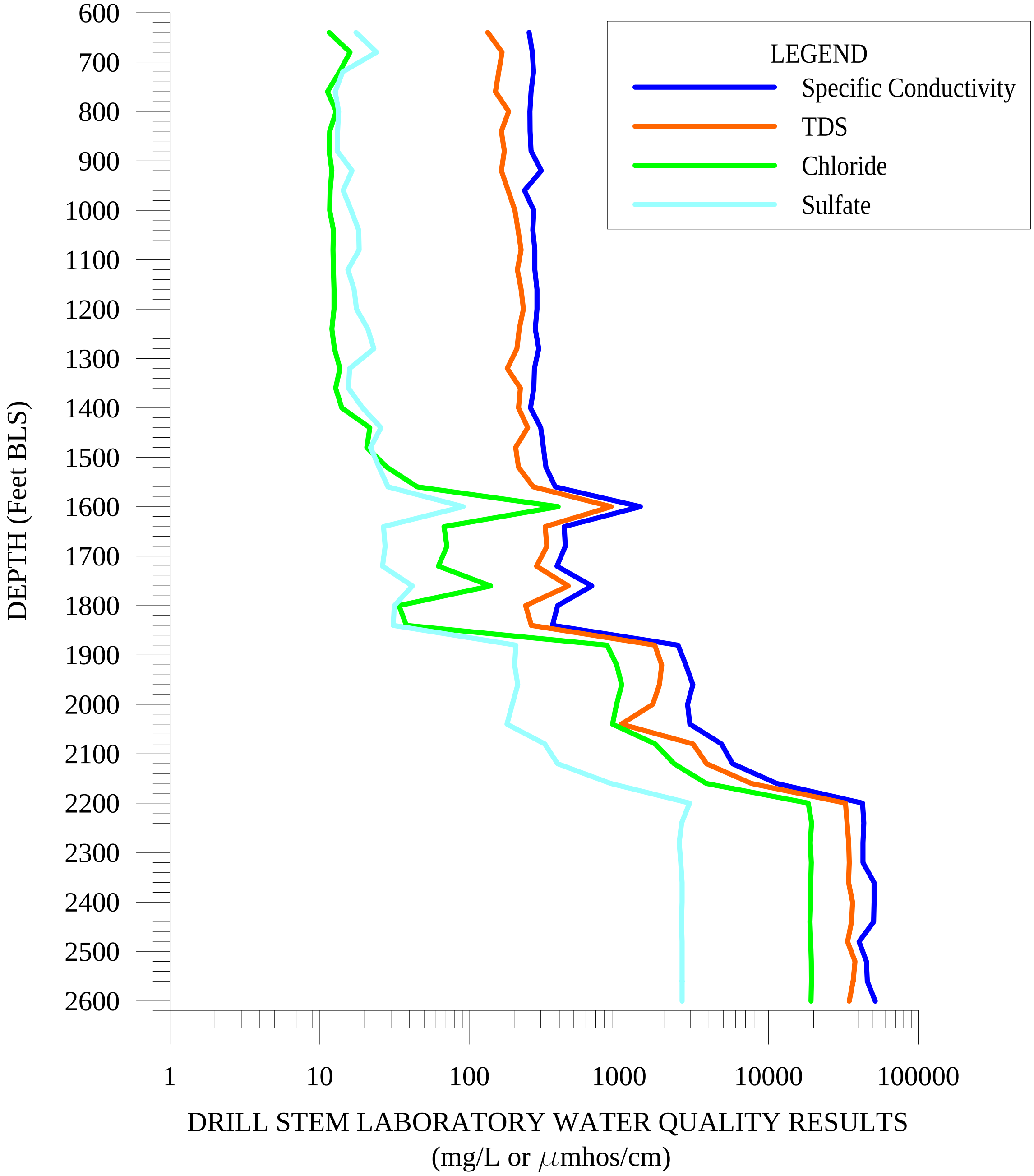
On January 28, 2008 Tetra Tech met with Chris Sweazy, P.G. (SFWMD) to discuss the results of the geophysical and video logging at the Cypress Lake site. The geophysical and video logs at LFMW-1, in conjunction with the drill-stem water quality results from LFMW-1 were reviewed to discuss the determination of hydrostratigraphic units at the Cypress Lake site and to discuss at what depth the final well casing should be installed in the LFA, at what depth the open-hole section should be drilled to in the LFA, and what intervals of the 8-inch pilot hole should be tested during straddle packer testing at LFMW-1. Tetra Tech identified areas of small diameter, and apparent low porosity, which were consistent with the MSCU from 630 to 780 feet BLS, and from 900 to 1,020 feet BLS. Areas of larger diameter and apparent high porosity were identified

TABLE 2-1
TOHOPEGALIKA WATER AUTHORITY
CYPRESS LAKE WELLFIELD EXPLORATORY TEST WELL
AQUIFER PERFORMANCE TESTING REPORT
LFMW-1 DRILL STEM WATER QUALITY RESULTS

Date and Time Sampled	Depth	pH (field)	Temperature (field)	Turbidity (field)	Conductivity	Total Dissolved Solids	Chloride	Hardness	Iron	Hydrogen Sulfide as S	Sulfate	Total Sulfide
	(ft bls)	(pH)	(Degrees C)	(SU)	(µmhos/cm)	(mg/L)	(mg/L)	(mg/L)	(mg/L	(mg/L)	(mg/L)	(mg/L)
10/01/07 15:25	640	8.33	251	11.5	251	133	11.6	96	0.153	0.07	17.5	1.48
10/04/07 10:48	680	7.80	264	41.6	264	166	16.0	104	0.497	0.14	24.1	0.99
10/16/07 09:45	720	7.17	26.6	6.0	269	158	13.6	124	0.289	0.92	14.3	2.30
10/17/07 09:25	760	8.3	25	2.8	259	150	11.3	109	0.515	0.21	12.7	3.01
10/17/07 15:00	800	8.5	26	0.90	254	184	12.9	125	0.161	0.07	13.4	1.50
10/17/07 13:45	840	8.6	25	3.70	255	164	11.7	121	0.375	0.07	13.2	1.67
10/17/07 12:40	880	8.7	26.3	6.34	259	172	11.6	125	0.572	0.04	13.1	1.29
10/22/07 17:40	920	8.7	26.4	8.54	304	164	12.1	118	0.192	0.04	16.5	1.95
10/23/07 07:00	960	8.8	24.5	15.2	234	182	11.8	131	0.287	0.02	14.4	1.27
10/23/07 19:00	1,000	8.8	26.5	5.94	270	202	11.7	113	0.192	0.02	16.3	1.36
10/24/07 15:00	1,040	8.8	24.4	6.52	266	212	12.4	115	0.294	0.02	18.3	1.41
10/24/07 17:00	1,080	8.8	24.6	15.3	275	222	12.3	119	0.259	0.03	18.4	2.35
10/24/07 16:15	1,120	8.9	25.7	14.3	275	210	12.4	123	0.427	0.02	15.5	2.42
10/25/07 00:50	1,160	8.8	24.6	11.2	284	222	12.5	116	0.417	0.04	17.0	2.53
10/25/07 09:45	1,200	8.9	22.7	9.28	284	230	12.5	120	0.260	0.03	17.7	2.67
10/25/07 04:10	1,240	8.9	24.2	12.3	276	216	12.1	122	0.410	0.03	21.0	2.73
10/25/07 11:40	1,280	8.9	23.3	51.5	291	208	12.6	144	0.460	0.02	23.1	2.00
10/31/07 23:45	1,320	8.8	24.5	28.2	273	180	13.7	159	0.616	0.05	15.9	2.24
11/01/07 10:15	1,360	8.9	25.2	30.2	270	220	12.8	135	0.551	0.02	15.6	2.26
11/01/07 19:30	1,400	8.9	24.5	28.4	257	214	14.1	149	0.621	0.03	19.4	2.53
11/02/07 11:30	1,440	8.8	25.4	62.8	300	246	21.7	163	0.564	0.05	25.7	2.32
11/05/07 08:25	1,480	9.0	21.5	34.4	313	204	20.7	130	0.339	0.01	21.9	2.46
11/06/07 13:20	1,520	8.9	23.3	20.1	326	214	28.3	142	0.404	0.03	25.0	2.46
11/06/07 16:30	1,560	9.1	24.1	0.36	376	268	45.0	166	0.541	0.01	28.7	2.34
11/08/07 12:45	1,600	8.8	23.3	41.3	1,392	888	393	262	0.540	0.02	91.2	2.42
11/12/07 16:45	1,640	9.1	24.7	23.8	432	322	68.0	139	0.309	0.01	26.8	1.16
11/13/07 10:30	1,680	9.0	25.3	30.6	439	330	70.9	134	0.564	0.01	27.5	0.77
11/14/07 09:30	1,720	9.1	24.4	34.9	386	282	62.4	144	0.707	0.01	26.4	0.96
11/15/07 15:30	1,760	9.0	25.4	30.5	661	460	139	172	0.388	0.01	41.8	0.80
11/19/07 13:15	1,800	NA	NA	NA	390	238	33.5	136	0.796	0.045	31.6	0.56
11/20/07 14:30	1,840	NA	NA	NA	360	260	37.7	141	0.646	0.045	31.1	0.40
11/21/07 11:30	1,880	8.8	25.3	91.8	2,490	1,738	833	413	2.21	0.01	205	0.32
11/26/07 15:00	1,920	8.9	27.0	48.0	2,800	1,936	968	412	1.37	0.01	201	0.28
11/27/07 06:00	1,960	8.8	25.7	29.7	3,120	1,864	1,043	474	2.88	0.04	211	2.64
11/28/07 13:25	2,000	8.9	25.8	43.0	2,880	1,684	964	437	1.36	0.01	194	0.32
11/29/07 07:00	2,040	8.9	23.4	7.6	2,980	1,040	906	422	0.736	0.01	179	0.56
11/29/07 12:30	2,080	8.8	26.9	17.2	4,840	3,134	1,752	618	1.03	0.01	320	0.1
12/04/07 11:00	2,120	8.7	22.9	17.5	5,750	3,860	2,340	796	1.01	0.01	390	0.28
12/05/07 09:30	2,160	8.7	21.3	16.9	11,350	7,680	3,840	2,072	1.20	0.01	882	0.36
12/06/07 10:30	2,200	5.5	22.5	4.97	42,400	32,700	18,420	5,683	1.91	0.01	2,960	0.1
12/10/07 15:30	2,240	8.5	25.0	20.3	43,300	33,460	19,370	5,861	2.34	0.02	2,630	0.56
12/12/07 09:00	2,280	8.5	24.0	19.2	42,700	34,300	19,000	5,806	2.44	0.01	2,530	0.10
12/12/07 13:00	2,320	8.5	25.1	18.1	48,400	34,540	19,300	5,784	2.55	0.01	2,590	0.10
12/13/07 09:00	2,360	8.5	22.7	24.2	50,653	34,200	19,180	6,032	2.83	0.01	2,640	0.10
12/13/07 15:00	2,400	8.6	25.6	21.9	50,791	36,400	19,110	5,516	2.96	0.01	2,640	0.01
12/14/07 11:30	2,440	8.5	24.0	16.3	50,428	35,800	18,900	6,047	2.79	0.01	2,620	0.10
12/17/07 14:00	2,480	8.4	23.9	15.0	40,200	33,700	19,120	5,729	1.95	0.01	2,640	0.16
12/18/07 09:30	2,520	8.6	19.5	12.0	45,100	37,800	19,270	5,590	2.02	0.12	2,640	0.01
12/18/07 15:00	2,560	8.6	22.5	29.2	45,700	36,800	19,340	5,584	2.34	0.12	2,640	0.01
12/19/07 11:30	2,600	8.5	23.1	7.6	51,700	34,600	19,200	5,566	2.15	0.10	2,640	0.01

NA = Not avaliable at the time these samples where taken.

FIGURE 2-2
TOHOPEKALIGA WATER AUTHORITY
CYPRESS LAKE WELLFIELD EXPLORATORY TEST WELL
AQUIFER PERFORMANCE TESTING REPORT
LFMW-1 DRILL STEM WATER QUALITY



from 1,030 to 1,170 feet BLS, from 1,270 to 1,290 feet BLS, and from 1,400 to 1,530 feet BLS, which were consistent with what we defined as the production zone with the upper portion of the LFA. Although areas of larger diameter and apparent high porosity were identified in the borehole from 1,560 to 1,610 feet BLS, this area was not chosen as part of the production zone because of the deterioration of water quality from a cavity identified at 1,600 and 1,610 feet BLS. Tetra Tech recommended that the bottom of the production zone be a minimum vertical distance of approximately 100 feet from where water quality begins to deteriorate, which was identified at 1,600 feet BLS. Mr. Sweazy agreed with Tetra Tech's identification of the MSCU (640 to 1,020 feet BLS), the production zone within the LFA (1,020 to 1,500 feet BLS), and areas of small diameter and apparent low porosity from 1,610 to 1,870 that appeared to coincide with good confinement below the production zone.

2.2.3.1 LFMW-1

The geophysical and video logging was conducted throughout the open-hole section of LFMW-1 at a depth of 600 to 2,602 feet BLS in January 2008. The purpose of the logging was to inspect the well casing and borehole, delineate potential water production zones, and interpretation of the penetrated lithology. The specified suites of geophysical logs performed were caliper, natural gamma, spontaneous potential, dual induction, temperature (static), fluid conductivity (static), flow (static and dynamic), and a borehole compensated sonic with variable density log.

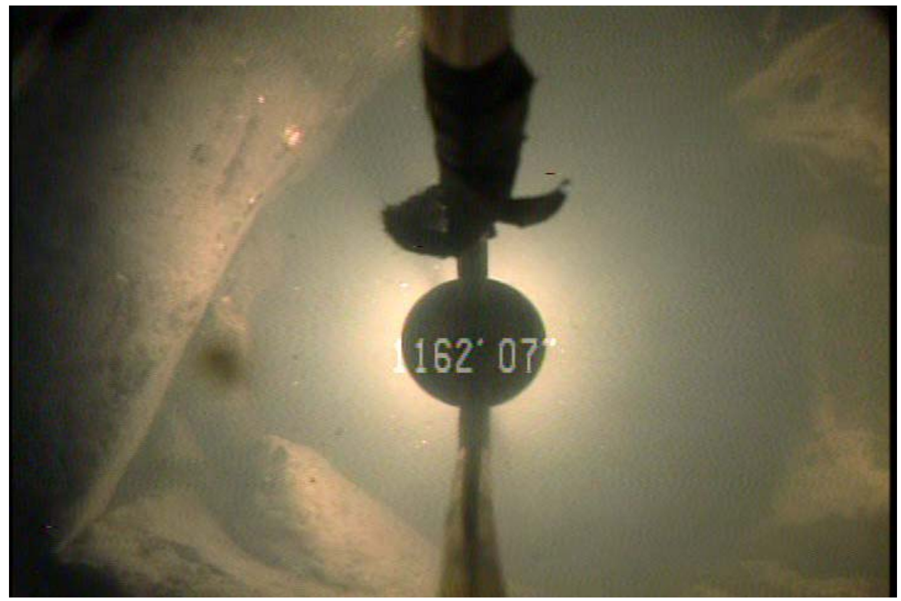
The video log was used to inspect the condition of interior casing (land surface to 600 feet BLS) and the open-hole section of the well (600 to 2,600 feet BLS). Particular attention was paid to the casing joints, the grout seal at the bottom of the casing, and areas of fracture and/or flow zones within the open-hole section of the well. The casing and joints were found to be in good shape, without distortion, cracks or leaks. The casing bottom was detected at 600 feet depth, it appeared to be well supported by cement and there did not appear to be any leakage around the casing. In the open-hole section of the well several areas of fracturing and jointing were detected that could be sources of water flow to the well. In addition, several layers within the rock show varied resistance and induration, creating narrow open areas. The bottom of the well was encountered at 2,598 feet and appeared to be a layer of soft dark colored sediment that had fallen out of suspension in the well. **Figures 2-3** and **2-4** are snapshots from the video log taken while in the MSCU, LFA, LCU, and the "boulder zone".

FIGURE 2-3
TOHOPEKALIGA WATER AUTHORITY
CYPRESS LAKE WELLFIELD EXPLORATORY TEST WELL
AQUIFER PERFORMANCE TESTING REPORT
DZMW-1 VIDEO LOG AQUIFER SNAP SHOT

Middle Semi-Confining Unit
640’ to 1,020’

Snapshot at a depth of 647 feet BLS.

Lower Floridan Aquifer
1,020’ to 1,600’



Snapshot at a depth of 1,162 feet BLS.

FIGURE 2-4
TOHOPEKALIGA WATER AUTHORITY
CYPRESS LAKE WELLFIELD EXPLORATORY TEST WELL
AQUIFER PERFORMANCE TESTING REPORT
DZMW-1 VIDEO LOG AQUIFER SNAP SHOT

Lower Confining Unit
1,600' to 2,600'

Snapshot at a depth of 2,006 feet BLS.

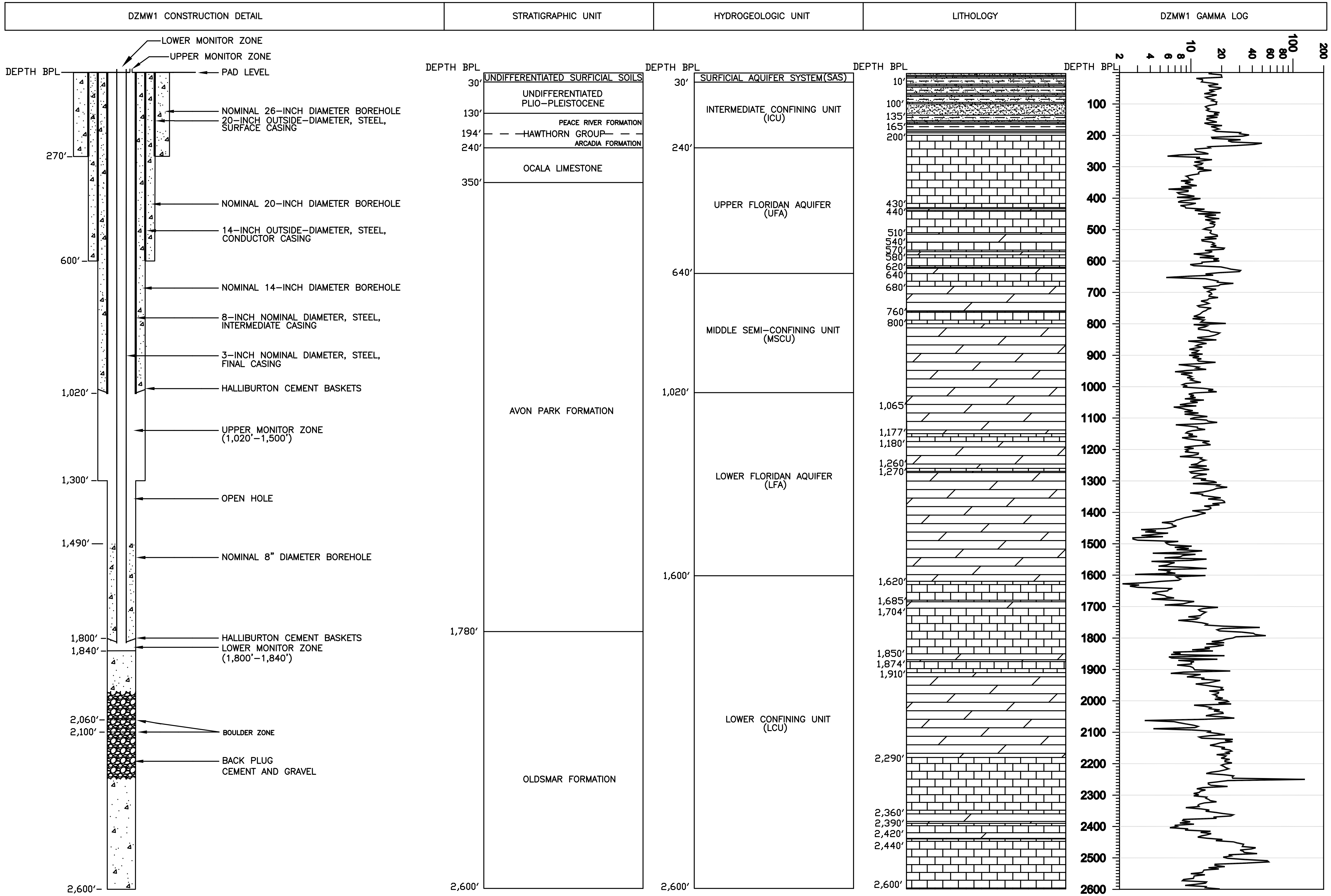
Boulder Zone
2,060' to 2,100'

Snapshot at a depth of 2,071 feet BLS.

Caliper log results indicate open-hole diameters between 8.5 and 39.5 inches from 600 to 2,600 feet BLS at LFMW-1. Open-hole diameters ranged from 13 to 17 inches between 640 and 1,020 feet BLS, with a well defined straight gauge hole diameter of 13 to 14 inches from 640 to 710 feet BLS, and from 960 to 1,020 feet BLS, that correlates well to the top and bottom of the MSCU. Open-hole diameters ranged from 14 to 17 inches from 1,020 to 1,140 feet BLS, and from 1,150 to 1,170 feet BLS, which correlate to areas of higher porosity or fracture within the production zone in the LFA. Caliper logs indicate that open-hole diameters were largest between 2,066 and 2,094 feet BLS, ranging from 20 to 39.5 inches which occurred in the "boulder zone". Straight gauge hole diameters of less than 10 inches were encountered below the production zone and the "boulder zone" from 2,100 to 2,375 feet BLS in uniform strata of hard to very hard lithology in the dolomitic limestones of the Avon Park and Oldsmar Formations.

The natural gamma ray count of the carbonate sediments of the Avon Park Formation is fairly consistent and low, ranging between 1.9 and 47.3 cps. High gamma ray counts occurred at 639.5 (30 cps) to 635.5 (30.8 cps) feet BLS near the top of the middle semi-confining unit. The increase in gamma between 1,760 and 1,800 feet BLS, 1,765 (31.3 cps) to 1,768 (32.1 cps) feet BLS, marks the contact between the Avon Park Formation and the underlying Oldsmar Formation, and is likely due to a buildup of gamma producing minerals. The highest gamma counts occurred at 1,791.5 feet BLS (50 cps) and 1,794 feet BLS (40 cps) near the formation contact, between 2,248 to 2,251 feet BLS (108.6 to 125 cps), and between 2,509 to 2,511 feet BLS (57.4 to 71.6 cps) within the Oldsmar Formation. **Figure 2-5** provides the construction detail, stratigraphic units, hydrostratigraphic units, lithology, and gamma log for DZMW-1.

The borehole compensated sonic with variable density log (acoustic) indicate areas of low porosity from 645 to 730 feet BLS, and from 900 to 1,025 feet BLS, that correlates well with the top and bottom of the MSCU. Areas of high porosity were identified from 1,030 to 1,075 feet BLS, 1,140 to 1,175 feet BLS, 1,268 to 1,292 feet BLS, and from 1,400 to 1,530 feet BLS in the acoustic log that correlates well to the production zone within the LFA. Additional areas of high porosity were identified from 1,563 to 1,610 feet BLS. The acoustic log at LFMW-1 indicate areas of low porosity exist from 1,612 to 2,055 feet BLS, which correlates well to an area of confinement below the production zone in the LFA. An area of high porosity was identified on the acoustic log from 2,060 to 2,110 feet BLS, which occurred in the "boulder zone".



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TOHOPEKALIGA WATER AUTHORITY
CYPRESS LAKE WELLFIELD EXPLORATORY TEST WELL
AQUIFER PERFORMANCE TESTING REPORT
DZMW-1 AND HYDROGEOLOGY

FIGURE 2-5

In the open-hole section below 600 feet BLS, the short normal induction log ranged from 1 to 165 ohm-meters with the highest recorded values between 2,109 to 2,127 feet BLS (98 to 165 ohm-meters). An increasing short normal induction profile occurs from 813 to 862 feet BLS (39.6 to 40.0 ohm-meters) and from 1,188 to 1,402 feet BLS (39.8 to 70.4 ohm-meters). The fluctuation of resistance between 2,080 and 2,130 feet BLS coincides with an opening of the borehole that is identified with the "boulder zone".

The static temperature log documented a stable temperature of 75.9ºF from the bottom of the casing (600 feet BLS) to a depth of 1,598 to 1,606 feet BLS, where it increased to a temperature of 81.3ºF, which correlates to an increase in fluid conductivity and a large void below the production zone in the LFA, that is likely connected to a lower portion of the LFA. The temperature in the borehole remained fairly stable at 81.3ºF from 1,606 feet to 2,120 feet BLS, then increased to 83.7ºF below 2,170 feet BLS, which correlates to an increase in fluid conductivity in the borehole. The temperature in the borehole continues to increase from 84.5ºF to a high of 87.1ºF from 2,350 feet to 2,600 feet BLS.

An analysis of the dynamic flow log for well LFMW-1 run at 500 gpm shows that the upper 50 feet of the open borehole (600 to 650 feet BLS) produced about 39% of the flow, the interval immediately around 700 feet BLS produced about 44% of the flow, the interval from 700 to 900 feet BLS produces about 13% of the flow, while the remaining 4% of the flow came from the remaining open borehole. The static flow log appears to indicate some downward flow from the upper Floridan aquifer down to about 1,600 feet BLS, which corresponds to the fluid conductivity logs where there is a dramatic increase in conductivity indicating a water quality change.

2.2.3.2 TPW-1

Aquifer Data Systems of Fort Myers, Florida performed video and geophysical logs throughout
Aquifer Data Systems of Fort Myers, Florida performed video and geophysical logs throughout
the open-hole section of the TPW-1 at a depth of 1,020 to 1,500 feet BLS on September 15, 2008. The logging was conducted after the completion of the constant rate discharge test (CRDT). The geophysical logs included caliper, static and dynamic flow, gamma ray, spontaneous potential, resistivity, acoustic, and temperature. Copies of these logs are included in **Appendix B**.

On the video log the casing and casing joints were inspected, as was the open-hole portion of the well. Particular attention was paid to the joints, the bottom of the casing, and areas of fracture and/or flow zones. The casing and joints were found to be in good shape, without distortion, cracks or leaks. The casing bottom was detected at 1,021 feet depth, it appeared to be well supported by cement and there did not appear to be any leakage from around the casing. In the open-hole section of the well several areas of fracturing and jointing were detected that could be sources of water flow to the well. In addition, several layers within the rock show varied resistance, creating narrow open areas. The bottom of the well was encountered at 1,496 feet and appeared to be a layer of soft dark colored material that had slowly built up in the well. **Figure 2-6** show snapshots from the video log taken while in the LFA.

The temperature and static flow logs were very stable, temperature remained below 79ºF, and barely rose above 80º near the bottom of the well. The flow logs showed very little movement of the water within the well. The dynamic flow log was conducted at a flow rate of 1,800 gpm and showed a gradual decrease in flow in the well with increasing depth. This indicates that water is contributed to the borehole from the entire open-hole section, and not just from narrow bands of high flow.

The caliper log is used to get a cross sectional view of the borehole and indicates zones of fracturing and areas of smooth rock. In TPW-1, the caliper log indicates a general widening of the borehole below the casing and extending down to about 1,200 feet BLS. Below 1,200 feet the borehole is generally close to the diameter of the drill bit (about 15 inches) with narrow bands of voids and fracture zones continuing to the bottom of the borehole, with a concentration between 1,380 and 1,420 feet BLS.

The resistivity log at TPW-1 used four detectors with spacings of 8, 16, 32 and 64 inches. The increasing spacing yielded resistivity readings that penetrated deeper into the water and rock. This can be used to estimate the resistivity of the water and the relative porosity of the rock. The resistivity was fairly stable between 75 to 250 ohm-meters from the bottom of the casing at 1,020 feet BLS until about 1,300 feet BLS, when it begins to rise to about 250 to 750 ohm-meters. Peaks of over 250 ohm-meters in the 8-inch log and 750 ohm/meters in the 64-inch log occur between 1,370 and 1,390 feet BLS. This depth corresponds to sections of narrow openings in an otherwise small diameter borehole as shown on the caliper log.

FIGURE 2-6
TOHOPEKALIGA WATER AUTHORITY
CYPRESS LAKE WELLFIELD EXPLORATORY TEST WELL
AQUIFER PERFORMANCE TESTING REPORT
TPW-1 VIDEO LOG AQUIFER SNAP SHOT

Lower Floridan Aquifer
1,020' to 1,600'

Snapshot at a depth of 1,042 feet BLS.

The gamma ray activity was very consistent throughout the entire borehole. The steel surface casing and cement attenuate the natural gamma radiation from the rocks and clays. This minimizes the gamma signature of the Hawthorn Group between roughly 130 and 240 feet BLS. Several square shouldered jumps in the gamma radiation appear throughout the gamma log. These are probably artifacts caused by electronic noise within the logger rather than actual spikes in radiation. Actual gamma spikes tend to slope up to a peak and then drop off with depth.

2.2.4 LFMW-1 Packer Testing

From February 29, 2008 to March 12, 2008 six packer tests were performed at the following intervals: 1,540 to 1,620 feet BLS, 1,610 to 1,690 feet BLS, 1,690 to 1,770 feet BLS, 1,860 to 1,940 feet BLS, 2,040 to 2,120 feet BLS, and 2,120 to 2,200 feet BLS. The packer intervals above were chosen based on the water quality results from the drill stem samples collected in the pilot borehole and from the geophysical logging conducted at LFMW-1. The intervals from 1,540 to 1,620 feet BLS, 1,860 to 1,940 feet BLS, 2,040 to 2,120 feet BLS, and 2,120 to 2,200 feet BLS were chosen to isolate and identify water quality within these intervals. The intervals from 1,610 to 1,690 feet BLS and 1,690 to 1,770 feet BLS were chosen to isolate and define confinement and water quality below the production zone.

The packer testing was conducted using a 10-inch diameter 84-foot long straddle packer assembly. The testing was conducted at these six intervals to derive formation water quality and drawdown. Each interval was purged until field water quality parameters of pH, millivolts (mV), temperature, conductivity, salinity, and turbidity were stabilized. Once water levels closely recovered to those from static conditions each interval was pumped for a period of four hours. The pumping period for the packer testing at 2,120 to 2,200 feet BLS was reduced due to the extremely high values of salinity ranging from 28,000 to 15,500 parts per million (ppm).

The drawdown levels found in each of the intervals ranged from 1.17 feet at interval 2,040 to 2,120 feet BLS to 6.70 feet at interval 1,610 to 1,690 feet BLS with pump rates ranging from 20 to 36 gpm. Considering the friction losses of the column pipe (roughly 0.224 feet of head loss per 100 feet of pipe) the observed drawdowns are extremely minimal. However the interval from 1,690 to 1,770 feet BLS produced a drawdown of 42.52 feet. The specific capacities at these intervals range from 30.3 gpm/ft at interval 2,040 to 2,120 feet BLS to 0.7 gpm/ft at interval 1,690 to 1,770 feet BLS.

Water quality samples were collected near the end of each packer test and submitted for laboratory analysis of pH, specific conductance, TDS, chloride, iron, hydrogen sulfide, sulfate, alkalinity, sodium, potassium, calcium, magnesium, fluoride, barium, total arsenic, oxygen 18, deuterium, gross alpha and radiocarbon (only collected and analyzed for the shallowest and deepest packer tests). In all six intervals there was at least one exceedance of the Florida Department of Environmental Protection's (FDEP) maximum contaminant levels (MCL) and the water quality MCL exceedance increased with depth. Provided in **Table 2-2** are the water quality results from each packer test.

TABLE 2-2
TOHOPEKALIGA WATER AUTHORITY
CYPRESS LAKE WELLFIELD EXPLORATORY TEST WELL
AQUIFER PERFORMANCE TESTING REPORT
LFMW-1 PACKER TESTING WATER QUALITY RESULTS

MAXIMUM CONTAMINANT LEVELS FOR SELECTED PARAMETERS

TABLE 1 Reference: 62-550.310

Analyte ID	CONTAMINANT	MAXIMUM CONTAMINANT LEVEL	UNITS	LFMW-1 1,540' to 1,620' 03/12/08	LFMW-1 1,610' to 1,690' 03/11/08	LFMW-1 1,690' to 1,770' 03/07/08	LFMW-1 1,860' to 1,940' 03/05/08	LFMW-1 2,040' to 2,120' 03/03/08	LFMW-1 2,120' to 2,200' 02/28/08
1930	Total Dissolved Solids	500.00	mg/L	192	378	**1,500**	**2,310**	**3,400**	**14,100**
N/A	Conductivity (Specific Conductance)	N/A	µmhos/cm	318	642	2,310	4,680	7,190	55,000
1925	pH	6.50 - 8.50	S. U.	8.17	8.12	7.88	7.87	7.89	7.09
1017	Chloride	250.00	mg/L	20.3	101	**602**	**1,021**	**1,810**	**21,200**
1055	Sulfate	250.00	mg/L	15.6	37.1	182	**266**	**354**	**2,990**
N/A	Alkalinity (as $CaCO_3$)	N/A	mg/L	105	106	98	92	81	106
1052	Sodium	160.000	mg/L	9.632	54.74	**234**	**552**	**832**	**8,889**
N/A	Potassium (as K)	N/A	mg/L	2.17	4.83	223.5	44	420	432
N/A	Calcium (as Ca)	N/A	mg/L	32.19	36.99	87	90.6	112	652
N/A	Magnesium (as Mg)	N/A	mg/L	8.74	14.81	40.66	72.5	108	1,004
1025	Fluoride	4.000	mg/L	0.32	0.31	0.52	0.36	0.21	0.18
N/A	Hydrogen Sulfide	N/A	mg/L	0.06	0.06	0.02	0.01	0.03	0.01
1028	Iron	0.30	mg/L	**0.7788**	**0.451**	**1.116**	**1.431**	**1.520**	**6.99**
1010	Barium	2.000	mg/L	0.030	0.034	0.0442	0.0425	0.0361	0.0394
1005	Total Arsenic	0.050	mg/L	< 0.0007	< 0.0007	< 0.0007	< 0.0007	0.0008	< 0.0007
N/A	Oxygen 18	N/A	$\delta^{18}O$	-2.64	-2.51	-2.42	-2.23	-2.28	0.42
N/A	Deuterium	N/A	$\delta^{2}H$	-12.48	-12.26	-12.13	-10.96	-11.88	2.98
N/A	Carbon 13	N/A	$\delta^{13}C$	-5.70	NA	NA	NA	NA	-6.54
4000	Gross Alpha	15	pCi/L	**21.8 +/- 9.1**	**30.4 +/- 11.7**	1 U +/- 4.9	11.8 +/- 25.8	**24.6 +/- 17.0**	**70.1 +/- 70.1**
N/A	Radiocarbon	N/A	BP	24,770 +/- 110	NA	NA	NA	NA	31,380 +/- 220

NA: Not Analyzed.
Bold and Highlighted: Exceeds Maximum Contaminant Level.
Lab error destroyed sample before problem was noted.

SECTION 3
UPPER FLORIDAN AQUIFER TESTING

3.1 Introduction

A step-drawdown test is typically conducted to evaluate the well efficiency (head loss due to well bore effects) to determine appropriate pump setting depth for normal operation. Results from step-drawdown testing distinguish observed drawdown in the pumping well from actual drawdown within the aquifer outside the well borehole. Step-drawdown testing was conducted at the original test/production well (TPW) to determine the specific capacity and well efficiency in the upper Floridan aquifer (UFA). A constant rate discharge test (CRDT) is typically conducted by pumping a well and observing the drawdown effects at surrounding observation wells to determine onsite aquifer parameters (transmissivity, storativity, and leakance). To obtain information about the aquifer parameters in the UFA, at the Cypress Lake site, a 72-hour CRDT, at the request of and partially funded by the South Florida Water Management District (SFWMD), was conducted. Tetra Tech designed the upper Floridan aquifer test and provided a summary of the testing procedures to the SFWMD for review and approval prior to bidding of the well construction and testing for the project. Data were analyzed from the UFA step drawdown test and CRDT and a report detailing well construction and aquifer test analysis was prepared. That report is summarized, herein, and included in total as **Appendix A.6**.

3.2 Step-Drawdown Test

On October 9, 2007, Tetra Tech conducted a step drawdown test at well TPW to determine specific capacity and well efficiency. Well TPW, at the time of testing, was open to a depth of 600 feet BLS with a 30-inch steel surface casing to a depth of 270 feet BLS. The step-drawdown test was performed at four discrete discharge rates, representing discharge steps of 60-minute duration and rates of 1,367, 1,969, 2,350 and 2,767 gallons per minute (gpm) followed by 60 minutes of recovery monitoring. The total continuous pumping time for the test was four hours with exactly one hour of pumping for each of the four steps. Specific capacities were calculated at 108.7 gpm/ft with a pumping rate of 1,367 gpm and a drawdown of 12.6 feet, 96.7 gpm/ft with a pumping rate of 1,969 gpm and a drawdown of 20.34 feet, 85.2 gpm/ft with a pumping rate of 2,350 gpm and a drawdown of 27.59 feet, and 79.7 gpm/ft with a pumping rate of 2,767 gpm and a drawdown of 34.71 feet. Using this data, a pump rate of 1,900 gpm was selected for the CRDT.

3.3 Constant Rate Discharge Test

A 72-hour, 1,900 gpm UFA CRDT was conducted from October 16 through October 19, 2007. Three UFA wells (UFMW-1, TPW and LFMW-2) and four surficial aquifer wells (SAS-1, SAS-2, SAS-3 and SAS-4) were monitored for background, pumping, and recovery water levels. In addition to the onsite wells listed above, a SFWMD well OSF-64 was used to observe water levels before, during and after the CRDT. Transmissivity, storativity, and leakance values for the UFA system at the wellfield were calculated using the Jacob-Cooper time drawdown semi-log approximation solution for the non-equilibrium equation, the Hantush-Jacob leaky aquifer method, the Theis transmissivity from residual drawdown and the Jacob-Cooper distance drawdown method. Transmissivity values of the UFA were calculated to be between 42,044 and 67,054 ft^2/d, storativity values were calculated to be between $4x10^{-5}$ and $2.8x10^{-3}$ and total leakance between $2.4x10^{-3}$ and $2.9x10^{-3}$ ft/d/ft.

SECTION 4
LOWER FLORIDAN AQUIFER PERFORMANCE TESTING

4.1 Introduction

A step-drawdown test is typically conducted to evaluate the well efficiency (head loss due to well bore effects) to determine appropriate pump setting depth for normal operation. Results from step-drawdown testing distinguish observed drawdown in the pumping well from actual drawdown within the aquifer outside the well borehole. Step-drawdown testing was conducted at the new test/production well (TPW-1) to determine the specific capacity and well efficiency in the lower Floridan aquifer (LFA). A constant rate discharge test (CRDT) is typically conducted by pumping a well and observing the drawdown effects at surrounding observation wells to determine onsite aquifer parameters (transmissivity, storativity, and leakance). The CRDT in the LFA at the TPW-1 was conducted to determine aquifer properties at the Cypress Lake site. These parameters are being used for local refinement or confirmation for calibration of a regional groundwater flow model that will be used to design and permit an alternative water supply wellfield.

4.2 Step-Drawdown Test

On August 4, 2008, Tetra Tech conducted a step drawdown test of TPW-1 to determine specific capacity and well efficiency. Well construction at the TPW-1, was completed to a total depth of 1,500 feet BLS, with an open-hole interval from 1,020 to 1,500 feet BLS. The step-drawdown test was performed at four discrete discharge rates, representing discharge steps of 60-minute duration and rates of 1,655, 2,200, 2,636 and 3,073 gallons per minute (gpm) followed by 60 minutes of recovery monitoring. The total continuous pumping time for the test was four hours with exactly one hour of pumping for each of the four steps. Specific capacity values for the four pumping steps ranged from 112.8 gpm/ft at 1,655 gpm to 87.8 gpm/ft at 3,073 gpm.

Tetra Tech employed the Hantush-Bierschenk method for evaluating well efficiency. In short, this method directly relates the observed drawdown to a component of aquifer and linear well losses, and a component of non-linear well losses. The method is valid assuming a fully penetrating well and a confined aquifer; both assumptions are reasonable for the duration of each step for the step drawdown test of TPW-1 based on lithologic inspection and subsequent aquifer testing. The pumped well efficiency values using the Hantush-Bierschenk method for the four pumping steps ranged from 66% at 1,655 gpm to 51% at 3,073 gpm. The step-drawdown test results and well efficiency graphs, along with the well efficiency calculations and hand measurements are provided in **Appendix C**.

4.2 Constant Rate Discharge Test

4.2.1 Water Level Data Loggers

A combination of vented and unvented pressure transducers with data loggers was used to measure water level changes, and a logger was deployed at the test location to record barometric pressure during the period of observation. Background water level readings were collected for one week prior to initiating the CRDT, throughout the duration of the 14-day CRDT, and for one week following the CRDT.

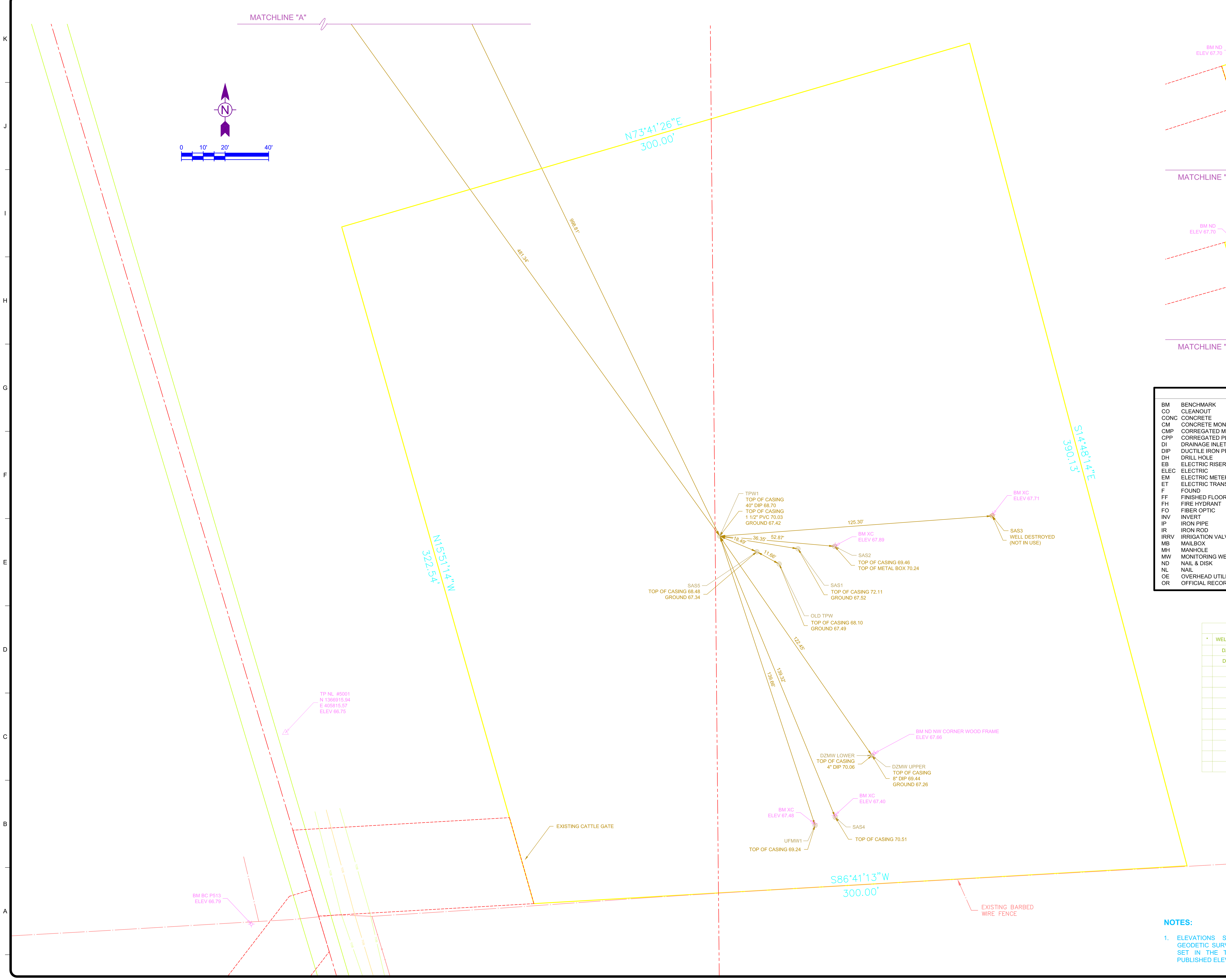
Onsite observation wells used during the CRDT are:

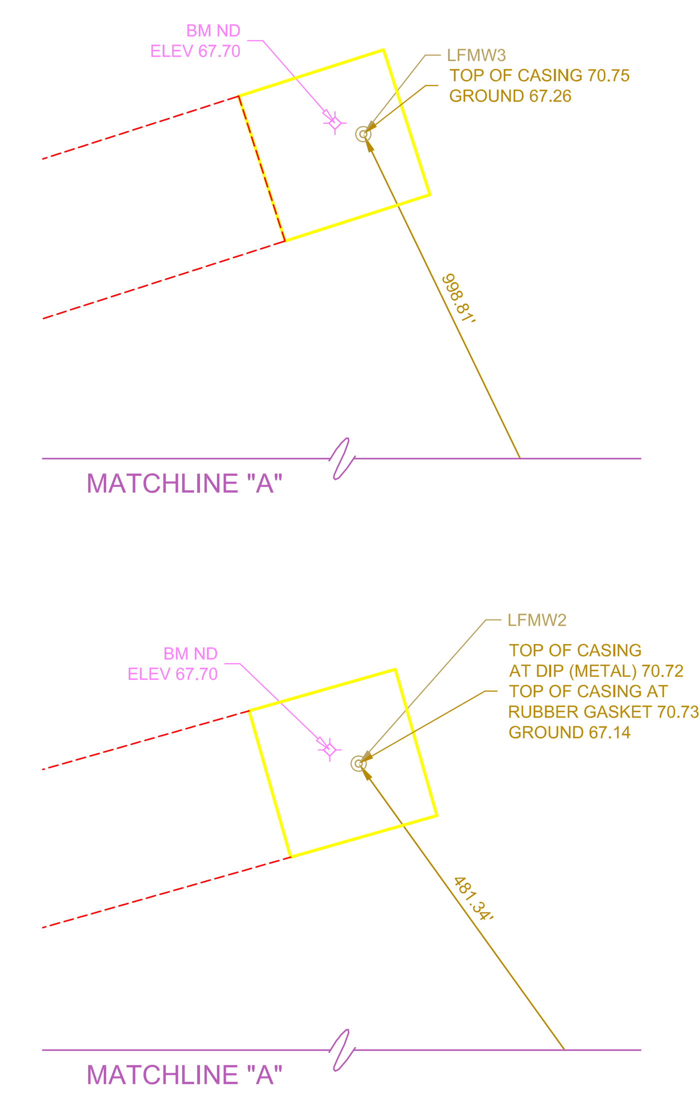
- Surficial aquifer well SAS-2;
- Upper Floridan aquifer well UFMW-1;
- Lower Floridan aquifer wells DZMW-1 (upper zone), LFMW-2 and LFMW-3;
- Lower confining unit well DZMW-1 (lower zone).

The location of each observation well in comparison to the location of TPW-1 is illustrated on **Figure 4-1**. **Table 4-1** summarizes the distances of the wells monitored during the CRDT from TPW-1 and the observation intervals during the test.

4.2.2 Regional Observation Wells

One South Florida Water Management District (SFWMD) monitor well OSF-104M was utilized prior to and during the CRDT to remove regional and antecedent trends from the CRDT data during the LFA CRDT. Well OSF-104M is approximately 31.6 miles southeast of the Cypress Lake test site, south of State Road 60 East near Fort Kissimmee, Florida. The data used for this





ABBREVIATIONS

BM	BENCHMARK	PB	PLAT BOOK
CO	CLEANOUT	PG	PAGE
CONC	CONCRETE	PM	PARKING METER
CM	CONCRETE MONUMENT	RCP	REINFORCED CONCRETE PIPE
CMP	CORREGATED METAL PIPE	RR	RAILROAD
CPP	CORREGATED PLASTIC PIPE	RW	RECLAIMED WATER
DI	DRAINAGE INLET	S	SET
DIP	DUCTILE IRON PIPE	SC	SECTION CORNER
DH	DRILL HOLE	SH	SPRINKLER HEAD
EB	ELECTRIC RISER	SPIG	WATER SPIGOT
ELEC	ELECTRIC	SS	SANITARY SEWER
EM	ELECTRIC METER	ST	STORM SEWER
ET	ELECTRIC TRANSFORMER	SV	SANITARY SEWER VALVE
F	FOUND	TB	TELEPHONE RISER
FF	FINISHED FLOOR	TEL	TELEPHONE
FH	FIRE HYDRANT	TP	TRAVERSE POINT
FO	FIBER OPTIC	TR	TRASH
INV	INVERT	TSC	TRAFFIC SIGNAL CONTROL
IP	IRON PIPE	TSP	TRAFFIC SIGNAL POLE
IR	IRON ROD	TV	CABLE TELVISION
IRRV	IRRIGATION VALVE	UE	UNDERGROUND UTILITY LINES
MB	MAILBOX	W	WATER
MH	MANHOLE	WH	WOODEN HUB
MW	MONITORING WELL	WM	WATER METER
ND	NAIL & DISK	WV	WATER VALVE
NL	NAIL	XC	X CUT
OE	OVERHEAD UTILITY LINES		
OR	OFFICIAL RECORDS		

WELL LOCATIONS

*	WELL DESIGNATOR	Northing	Easting
	DZMW LOWER	1366905.51	406084.56
	DZMW UPPER	1366905.51	406084.56
	LFMW2	1367396.75	405733.53
	LFMW3	1367905.16	405579.67
	OLD TPW	1366993.33	406042.00
	SAS1	1367000.30	406050.62
	SAS2	1367001.42	406067.39
	SAS3	1367015.38	406139.69
	SAS4	1366877.23	406067.69
	SAS5	1366998.93	406031.78
	TPW1	1367006.09	406014.73
	UFMW1	1366873.46	406058.47

NOTES:

1. ELEVATIONS SHOWN HEREON ARE BASED ON NATIONAL GEODETIC SURVEY BENCHMARK # P 513, BEING A SURVEY DISK SET IN THE TOP OF A CONCRETE MONUMENT, HAVING A PUBLISHED ELEVATION OF 66.79. (NGVD 1929)

TETRA TECH
www.tetratech.com
201 EAST PINE STREET, SUITE 1000
ORLANDO, FL 32801
PHONE: (407) 839-3955 FAX: (407) 839-3790

MARK	DATE	DESCRIPTION	BY

Client: TOHO WATER AUTHORITY
Proj. Loc.: OSCEOLA COUNT, FLORIDA

SPECIFIC PURPOSE SURVEY OF THE

WELL LOCATIONS

Project No.:	95.0076.085
Designed By:	N/A
Drawn By:	CIS
Checked By:	LEJ

FIG 4-1

TABLE 4-1
TOHOPEKALIGA WATER AUTHORITY
CYPRESS LAKE WELLFIELD EXPLORATORY TEST WELL
AQUIFER PERFORMANCE TESTING REPORT
RADIAL DISTANCES AND OBSERVATION INTERVALS

WELL ID	HYDROSTRATIGRAPHIC UNIT	DISTANCE FROM TPW-1 (ft)
TPW-1	aquifer (LFA)	0
DZMW-1 (upper zone)	aquifer (LFA)	122
DZMW-1 (lower zone)	confining unit (LCU)	122
UFMW-1	aquifer (UFA)	140
LFMW-2	aquifer (LFA)	481
LFMW-3	aquifer (LFA)	999
SAS-2	surficial aquifer	53

test is from the middle interval of a triple-zone monitoring well. It is open to the "Middle Floridan Aquifer," or the upper portion of the lower Floridan aquifer between 930 to 1,150 feet BLS.

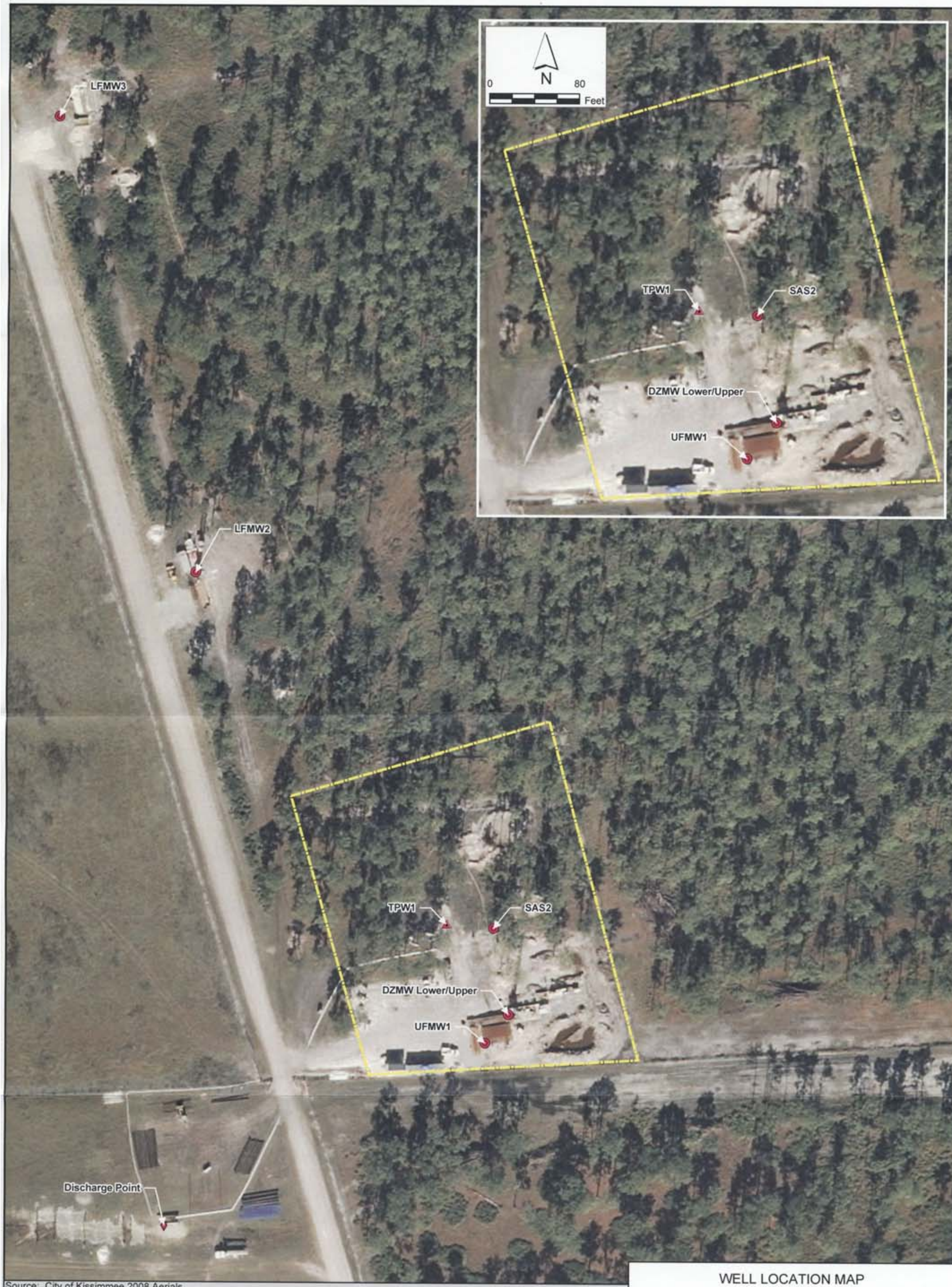
4.2.3 Testing Summary

The pumping portion of the CRDT of the LFA was started at 10:01 A.M. on August 12, 2008 and terminated at 12:00 P.M. on August 26, 2008. Well TPW-1 was pumped at an apparent instantaneous discharge of 2,000 gpm with an overall weighted average discharge for the duration of the test of 2,057 gpm. Discharge totalizer readings for the length of the test are included as **Appendix D.1**.

Water levels were monitored throughout the test in onsite wells TPW-1, UFMW-1, LFMW-2, LFMW-3, DZMW-1 (upper and lower zones) and SAS-2. Provided in **Appendix D.1** is a table of manual water level readings for the wells mentioned above. Water from the CRDT was discharged more than 400 feet away from well TPW-1 into a drainage swale flowing west toward Cypress Lake. The locations of the discharge point as well as all on-site observation wells are shown on **Figure 4-2**.

In addition to the totalizer and water level data collected during the CRDT, field water quality parameters were also measured and recorded. The monitored parameters and analytes included pH, conductivity, temperature, iron, chloride, hydrogen sulfide, and turbidity. The measured values for these field parameters and analytes are provided in **Appendix D.1**.

On August 20 and 26, 2008, water quality samples were collected from well TPW-1 for analysis of primary and secondary drinking water standards including all other parameters as listed in **Table 4-2**. The first set of samples was delivered to Pace Analytical Services, Inc. and the second set of samples was delivered to TestAmerica Laboratories, Inc. for analysis. Lab results provided in **Appendix D.2** indicate that one parameter (from each sample) was in exceedance of the Florida Department of Environmental Protection's (FDEP) maximum contaminant level (MCL) standards for odor. Odor was identified at a value of 8.0 threshold odor number (TON) for each sample analyzed. The MCL exceedance limit for odor is 3.0 TON. However all other values tested were below the FDEP MCL standards.



Source: City of Kissimmee 2008 Aerials

LEGEND

- Monitor Well Location
- Test Production Well Location
- Discharge Point
- Work Area

WELL LOCATION MAP
TOHOPEKALIGA WATER AUTHORITY
CYPRESS LAKE WELLFIELD
EXPLORATORY TEST WELL
AQUIFER PERFORMANCE TESTING REPORT

N
0 100 Feet

TETRA TECH

FIGURE 4-2

TT11X17P3\GIS\TohoWaterAuth\950076085\maps\CypressLake_BPWSF4-2.mxd [09-30-08 bam]

TABLE 4-2
TOHOPEKALIGA WATER AUTHORITY
CYPRESS LAKE WELLFIELD EXPLORATORY TEST WELL
AQUIFER PERFORMANCE TESTING REPORT
TPW-1 WATER QUALITY PARAMETER RESULTS

PRIMARY DRINKING WATER STANDARDS

MAXIMUM CONTAMINANT LEVELS FOR INORGANIC CONTAMINANTS

Reference: 62-550.310(1)

				Pace Analytical Services, Inc.	Southern Analytical Laboratories, Inc.	TestAmerica Laboratories, Inc.
CONTAMINANT ID	**CONTAMINANT**	**MAXIMUM CONTAMINANT LEVEL**	**UNITS**	**TPW-1 8/20/08**	**TPW-1 8/20/08 (split)**	**TPW-1 8/26/08**
1074	Antimony	0.006	mg/L	0.0054	NA	0.00024
1005	Arsenic	0.050	mg/L	< 0.00050	NA	< 0.0040
1010	Barium	2.000	mg/L	0.10	0.099	< 0.092
1075	Beryllium	0.004	mg/L	< 0.00050	NA	< 0.0050
1015	Cadmium	0.005	mg/L	< 0.00050	NA	< 0.0010
1020	Chromium	0.100	mg/L	< 0.0025	NA	< 0.0020
1024	Cyanide	0.200	mg/L	< 0.0028	NA	< 0.0050
1025	Fluoride	4.000	mg/L	0.34	NA	< 0.50
1030	Lead	0.015	mg/L	< 0.00050	NA	0.0012
1035	Mercury	0.002	mg/L	< 0.000020	NA	< 0.000072
1036	Nickel	0.100	mg/L	< 0.0025	NA	< 0.0020
1040	Nitrate (as N)	10.000	mg/L	< 0.012	NA	< 0.10
1041	Nitrite (as N)	1.000	mg/L	< 0.0051	NA	< 0.10
N/A	Total Nitrate/Nitrite (as N)	10.000	mg/L	< 0.017	NA	< 0.10
1045	Selenium	0.050	mg/L	0.023	NA	< 0.0050
1052	Sodium	160.000	mg/L	51	NA	50
1085	Thallium	0.002	mg/L	< 0.00050	NA	< 0.000096

MAXIMUM CONTAMINANT LEVELS FOR DISINFECTION BYPRODUCTS

Reference: 62-550.310(3)

				Pace Analytical Services, Inc.	Southern Analytical Laboratories, Inc.	TestAmerica Laboratories, Inc.
CONTAMINANT ID	**CONTAMINANT**	**MAXIMUM CONTAMINANT LEVEL**	**UNITS**	**TPW-1 8/20/08**	**TPW-1 8/20/08 (split)**	**TPW-1 8/26/08**
1011	Bromate	10	µg/L	< 1.8	NA	NA
1009	Chlorite	1,000	µg/L	< 3.2	NA	NA
2453	Bromoacetic Acid	N/A	µg/L	NA	NA	NA
2450	Chloroacetic Acid	N/A	µg/L	NA	NA	NA
2454	Dibromoacetic Acid	N/A	µg/L	< 0.128	NA	< 0.38
2451	Dichloroacetic Acid	N/A	µg/L	< 0.130	NA	< 1.1
2453	Monobromoacetic Acid	N/A	µg/L	< 0.0720	NA	< 0.75
2450	Monochloroacetic Acid	N/A	µg/L	< 0.0820	NA	< 0.97
2452	Trichloroacetic Acid	N/A	µg/L	< 0.238	NA	< 0.19
2456	Total Haloacetic Acids (HAA5)	60	µg/L	< 1.00	NA	< 0.19
2943	Bromodichloromethane (Dichlorobromomethane)	N/A	µg/L	< 0.25	NA	< 0.19
2942	Bromoform	N/A	µg/L	< 0.25	NA	< 0.17
2941	Chloroform	N/A	µg/L	< 0.25	NA	< 0.20
2944	Dibromochloromethane (Chlorodibromomethane)	N/A	µg/L	< 0.25	NA	< 0.16
2950	Total Trihalomethanes (THM)	80	µg/L	< 0.50	NA	< 0.16

TABLE 4-2
TOHOPEKALIGA WATER AUTHORITY
CYPRESS LAKE WELLFIELD EXPLORATORY TEST WELL
AQUIFER PERFORMANCE TESTING REPORT
TPW-1 WATER QUALITY PARAMETER RESULTS

MAXIMUM CONTAMINANT LIMITS FOR VOLATILE ORGANICS

Reference: 62-550.310(4)(a)

				Pace Analytical Services, Inc.	Southern Analytical Laboratories, Inc.	TestAmerica Laboratories, Inc.
CONTAMINANT ID	**CONTAMINANT**	**MAXIMUM CONTAMINANT LEVEL**	**UNITS**	**TPW-1 8/20/08**	**TPW-1 8/20/08 (split)**	**TPW-1 8/26/08**
2977	1,1-Dichloroethylene	7	μg/L	< 0.25	NA	< 0.24
2981	1,1,1-Trichloroethane	200	μg/L	< 0.25	NA	< 0.16
2985	1,1,2-Trichloroethane	5	μg/L	< 0.25	NA	< 0.25
2980	1,2-Dichloroethane	3	μg/L	< 0.25	NA	< 0.19
2983	1,2-Dichloropropane	5	μg/L	< 0.25	NA	< 0.22
2378	1,2,4-Tricholorobenzene	70	μg/L	< 0.25	NA	< 0.38
2990	Benzene	1	μg/L	< 0.25	NA	< 0.19
2982	Carbon tetrachloride	3	μg/L	< 0.25	NA	< 0.38
2380	cis-1,2-Dichloroethylene	70	μg/L	< 0.25	NA	< 0.25
2964	Dichloromethane (Methylene chloride)	5	μg/L	< 0.32	NA	< 0.21
2992	Ethylbenzene	700	μg/L	< 0.35	NA	< 0.18
2989	Monochlorobenzene (chlorobenzene)	100	μg/L	< 0.25	NA	< 0.19
2968	o-Dichlorobenzene (1,2-dicholorobenzene)	600	μg/L	< 0.25	NA	< 0.23
2969	para-Dichlorobenzene (1,4-dicholorobenzene)	75	μg/L	< 0.25	NA	< 0.17
2996	Styrene	100	μg/L	< 0.25	NA	< 0.30
2987	Tetrachloroethylene	3	μg/L	< 0.25	NA	< 0.22
2991	Toluene	1,000	μg/L	0.32	NA	< 0.21
2979	trans-1,2-Dichloroethylene	100	μg/L	< 0.25	NA	< 0.22
2984	Trichloroethylene	3	μg/L	< 0.25	NA	< 0.20
2976	Vinyl chloride	1	μg/L	< 0.25	NA	< 0.29
2955	Xylenes (total)	10,000	μg/L	< 0.25	NA	< 0.44

TABLE 4-2
TOHOPEKALIGA WATER AUTHORITY
CYPRESS LAKE WELLFIELD EXPLORATORY TEST WELL
AQUIFER PERFORMANCE TESTING REPORT
TPW-1 WATER QUALITY PARAMETER RESULTS

MAXIMUM CONTAMINANT LEVELS FOR SYNTHETIC ORGANICS

Reference: 62-550.310(4)(b)

				Pace Analytical Services, Inc.	Southern Analytical Laboratories, Inc.	TestAmerica Laboratories, Inc.
CONTAMINANT ID	**CONTAMINANT**	**MAXIMUM CONTAMINANT LEVEL**	**UNITS**	**TPW-1 8/20/08**	**TPW-1 8/20/08 (split)**	**TPW-1 8/26/08**
2063	2,3,7,8-TCDD (Dioxin)	$3x10^{-5}$	µg/L	< 5.0	NA	NA
2105	2,4-D	70.00	µg/L	< 0.054	NA	< 0.046
2110	2,4,5-TP (Silvex)	50.00	µg/L	< 0.038	NA	< 0.046
2051	Alachlor	2.00	µg/L	< 0.029	NA	< 0.058
2050	Atrazine	3.00	µg/L	< 0.0070	NA	< 0.041
2306	Benzo(a)pyrene	0.20	µg/L	< 0.036	NA	< 0.024
2046	Carbofuran	40.00	µg/L	< 0.13	NA	< 0.084
2959	Chlordane	2.00	µg/L	< 0.019	NA	< 0.025
2031	Dalapon	200.00	µg/L	< 0.6	NA	< 0.057
2035	Di(2-ethylhexyl)adipate	400.00	µg/L	< 0.23	NA	< 0.48
2039	Di(2-ethylhexyl)phthalate	6.00	µg/L	< 0.50	NA	< 0.48
2931	Dibromochloropropane (1,2-dibromo-3-chloropropane)	0.20	µg/L	< 0.0040	NA	< 0.010
2041	Dinoseb	7.00	µg/L	< 0.096	NA	< 0.052
2032	Diquat	20.00	µg/L	< 0.21	NA	< 0.092
2033	Endothall	100.00	µg/L	< 0.3	NA	< 2.6
2005	Endrin	2.00	µg/L	< 0.0020	NA	< 0.12
2946	Ethylene Dibromide (EDB or 1,2-dibromoethane)	0.02	µg/L	< 0.0062	NA	< 0.0087
2034	Glyphosate	700.00	µg/L	< 0.99	NA	< 2.7
2065	Heptachlor	0.40	µg/L	< 0.0060	NA	< 0.037
2067	Heptachlor Epoxide	0.20	µg/L	< 0.0010	NA	< 0.088
2274	Hexachlorobenzene	1.00	µg/L	< 0.012	NA	< 0.031
2042	Hexachlorocyclopentadiene	50.00	µg/L	< 0.014	NA	< 0.054
2010	Lindane (gamma-BHC)	0.20	µg/L	< 0.0020	NA	< 0.066
2015	Methoxychlor	40.00	µg/L	< 0.014	NA	< 0.096
2036	Oxamyl (Vydate)	200.00	µg/L	< 0.16	NA	< 0.25
2326	Pentachlorophenol	1.00	µg/L	< 0.0040	NA	< 0.025
2040	Picloram	500.00	µg/L	< 0.037	NA	< 0.10
2383	Polychlorinated biphenyl (PCB)	0.50	µg/L	< 0.10	NA	< 0.091
2037	Simazine	4.00	µg/L	< 0.019	NA	< 0.073
2020	Toxaphene	3.00	µg/L	< 0.23	NA	< 0.24

TABLE 4-2
TOHOPEKALIGA WATER AUTHORITY
CYPRESS LAKE WELLFIELD EXPLORATORY TEST WELL
AQUIFER PERFORMANCE TESTING REPORT
TPW-1 WATER QUALITY PARAMETER RESULTS

MAXIMUM CONTAMINANT LEVELS FOR RADIONUCLIDES

Reference: 62-550.310(6)

				Pace Analytical Services, Inc.	Southern Analytical Laboratories, Inc.	TestAmerica Laboratories, Inc.
CONTAMINANT ID	**CONTAMINANT**	**MAXIMUM CONTAMINANT LEVEL**	**UNITS**	**TPW-1 8/20/08**	**TPW-1 8/20/08 (split)**	**TPW-1 8/26/08**
4000	Gross Alpha (Excl Uranium)	15**	pCi/L	5.0 +/- 1.0	NA	7.2 +/- 1.2
4002	Gross Alpha (Incl Uranium)	***	pCi/L	NA	NA	NA
4006	Combined Uranium (U-234, U-235, & U-238)	30****	pCi/L	< 1.1 +/- 0.7	NA	0.6 +/- 0.2
4020	Radium-226	5	pCi/L	2.0 +/- 0.2	NA	3.7 +/- 0.8
4030	Radium-228	5	pCi/L	< 0.9 +/- 0.6	NA	0.0 +/- 0.6
NA	Gross Beta	NA	pCi/L	4.0 +/- 0.8	NA	4.6 +/- 0.8
NA	Radon-222	NA	pCi/L	99.6 +/- 28.1	NA	74 +/- 4

** If the results exceed 5 pCi/L, a measurement for radium-226 is required.

*** If the results exceed 5 pCi/L, a measurements for radium-226 is required. If the results exceed 15 pCi/L, measurements for radium-226 and uranium are required.

**** If uranium (U) is reported as a measurement of activity (pCi/L) it will be converted to a mass measurement (µg/L) by multiplying the result by 1.5.

SECONDARY DRINKING WATER STANDARDS

Reference: 62-550.320

				Pace Analytical Services, Inc.	Southern Analytical Laboratories, Inc.	TestAmerica Laboratories, Inc.
CONTAMINANT ID	**CONTAMINANT**	**MAXIMUM CONTAMINANT LEVEL**	**UNITS**	**TPW-1 8/20/08**	**TPW-1 8/20/08 (split)**	**TPW-1 8/26/08**
1002	Aluminum	0.20	mg/L	< 0.0050	NA	< 0.050
1017	Chloride	250.00	mg/L	87	99	93
1022	Copper	1.00	mg/L	< 0.00050	NA	< 0.0029
1025	Fluoride	2.00	mg/L	0.34	NA	< 0.50
2905	Foaming Agents (Surfactants as LAS)	0.50	mg/L	0.040	NA	0.063
1028	Iron	0.30	mg/L	< 0.020	NA	< 0.050
1032	Manganese	0.05	mg/L	< 0.0025	NA	< 0.0010
1050	Silver	0.10	mg/L	< 0.0025	NA	< 0.0010
1055	Sulfate	250.00	mg/L	82	NA	100
1095	Zinc	5.00	mg/L	< 0.010	NA	< 0.0050
1905	Color	15.00	CU	10.0	NA	**15**
1920	Odor	3.00	TON	**8.0**	NA	**8.0**
1925	pH	6.50 - 8.50	SU	7.64	7.6	7.25
1930	Total Dissolved Solids	500.00	mg/L	440	420	430

TABLE 4-2
TOHOPEKALIGA WATER AUTHORITY
CYPRESS LAKE WELLFIELD EXPLORATORY TEST WELL
AQUIFER PERFORMANCE TESTING REPORT
TPW-1 WATER QUALITY PARAMETER RESULTS

ADDITIONAL CONTAMINANTS ANALYZED

				Pace Analytical Services, Inc.	Southern Analytical Laboratories, Inc.	TestAmerica Laboratories, Inc.
CONTAMINANT ID	**CONTAMINANT**	**MAXIMUM CONTAMINANT LEVEL**	**UNITS**	**TPW-1 8/20/08**	**TPW-1 8/20/08 (split)**	**TPW-1 8/26/08**
N/A	Alkalinity, Total (as $CaCO_3$)	N/A	mg/L	130	NA	120
N/A	Ammonia (as N)	N/A	mg/L	0.27	NA	0.32
N/A	BOD5	N/A	mg/L	4.2	NA	< 2.0
N/A	Bicarbonate Alkalinity (as $CaCO_3$)	N/A	mg/L	130	NA	120
N/A	Bromide	N/A	mg/L	0.330	0.49	1.9
N/A	COD	N/A	mg/L	27	NA	16
N/A	Calcium - ICP Method	N/A	mg/L	70	NA	64
N/A	Calcium Hardness (as $CaCO_3$)	N/A	mg/L	170	NA	230
N/A	Carbonate Alkalinity (as $CaCO_3$)	N/A	mg/L	< 5.0	NA	< 1.0
N/A	Chlorine Residual	N/A	mg/L	< 0.10	< 0.1	< 0.10
N/A	Chlorine Residual Formation Potential (7day)	N/A	mg/L	NA	5.0	
N/A	Conductivity (Specific Conductance)	N/A	µmhos/cm	706	777	700
N/A	Hardness, Total (as $CaCO_3$)	N/A	mg/L	240	NA	NA
N/A	Heterotrophic Plate Count	N/A	CFU/mL	25	NA	< 1.0
N/A	Hydrogen Sulfide	N/A	mg/L	0.56	0.05	NA
N/A	Magnesium (ICP Method)	N/A	mg/L	17	NA	16
N/A	OrthoPhosphate - ICP Method (as PO_4)	N/A	mg/L	< 0.070	NA	0.0057
N/A	Phosphorus, Total (as P)	N/A	mg/L	< 0.05	NA	0.13
N/A	Potassium (ICP Method)	N/A	mg/L	3.3	NA	2.4
N/A	Silica (as SiO_2)	N/A	mg/L	14	NA	16
N/A	Strontium	N/A	mg/L	16	NA	NA
N/A	Sulfide	N/A	mg/L	1.8	NA	3.5
N/A	Total Carbon Dioxide	N/A	mg/L	3.0	NA	6.8
N/A	Total Kjeldahl Nitrogen	N/A	mg/L	0.51	NA	0.82
N/A	Total Organic Carbon	N/A	mg/L	4.8	4.4	4.3
N/A	Turbidity	N/A	NTU	0.180	NA	< 0.100

DISINFECTION BY-PRODUCT FORMATION POTENTIAL

				Pace Analytical Services, Inc.	Southern Analytical Laboratories, Inc.	TestAmerica Laboratories, Inc.
CONTAMINANT ID	**CONTAMINANT**	**MAXIMUM CONTAMINANT LEVEL**	**UNITS**	**TPW-1 8/20/08**	**TPW-1 8/20/08 (split)**	**TPW-1 8/26/08**
NA	Bromoacetic Acid	N/A	µg/L	NA	NA	NA
NA	Chloroacetic Acid	N/A	µg/L	NA	NA	NA
2454	Dibromoacetic Acid	N/A	µg/L	NA	10	5.7
2451	Dichloroacetic Acid	N/A	µg/L	NA	39	14
2453	Monobromoacetic Acid	N/A	µg/L	NA	14	1.4
2450	Monochloroacetic Acid	N/A	µg/L	NA	< 1	2.0
2452	Trichloroacetic Acid	N/A	µg/L	NA	47	15
2456	Total Haloacetic Acids (HAA5)	N/A	µg/L	NA	138	38.1

2943	Bromodichloromethane	N/A	µg/L	NA	87	11
2942	Bromoform	N/A	µg/L	NA	5.6	2.7
2941	Dibromochloromethane	N/A	µg/L	NA	57	11
2944	Chloroform	N/A	µg/L	NA	130	11
2950	Total Trihalomethanes (THM)	N/A	µg/L	NA	280	35.7

NA: Not Analyzed.
Bold and Highlighted: Exceeds Maximum Contaminant Level.

Rainfall and barometric pressure were recorded during the 14-day CRDT. A barometric pressure logger (referred to as a "barologger") recorded barometric pressure at 5-minute intervals during the test. A high resolution pressure transducer was used to record incremental increases in water level in an open-top rain gauge. No barometric pressure data was recovered from the barologger deployed during the background data collection period. Consequently, barometric pressure data from six regional locations were examined to identify suitable surrogates for the absent on-site pressure data. Comparisons made between the six regional data sets and on-site barologger data identified two locations, Orlando Executive Airport and Melbourne International Airport, as most representative of the area during the period of observation. A surrogate barometric pressure time series was created and used to correct antecedent water level observations.

Tropical Storm Fay produced a series of heavy wind and rain periods during the CRDT. The storm's passage is evident from a sudden drop in pressure identified in the barologger data and well hydrograph records for August 20, 2008. As a result, barometric pressure data during the CRDT fluctuated between 34.1 and 33.3 feet of water, while rainfall during the CRDT exceeded 6.0 inches. The rainfall during the background, testing and recovery periods of the CRDT is provided in **Appendix D.3** on the surficial aquifer hydrograph.

Pumping test recovery water level measurements were recorded manually for one hour after the conclusion of the test (12:00 P.M. on August 26, 2008) and electronically using water level loggers in Wells SAS-2, UFMW-1, LFMW-2, LFMW-3, DZMW-1 (upper and lower zones) and TPW-1 until the morning of September 2, 2008, a period of seven days. Recovery data were also analyzed to calculate aquifer hydraulic properties.

4.2.4 Analyses

4.2.4.1 Hydrographs

The wells used to determine the hydrogeologic parameters include the pumping well, TPW-1, and three LFA observation wells (DZMW-1 (upper zone), LFMW-2 and LFMW-3) constructed to the same casing depth (1,020 feet BLS) and total depth (1,500 feet BLS) as well TPW-1. Hydrographs for these four LFA wells along with the upper Floridan aquifer monitor well (UFMW-1), the lower Floridan confining unit monitor well (DZMW-1 lower zone), and a surficial aquifer well (SAS-2) are provided in **Appendix D.3**. The background, pumping, and recovery portions of the CRDT are marked on the hydrographs for reference. Manual measurements, identified with a "+" symbol, are also shown on the hydrographs.

Two sets of water level data were collected from each well during the test. Tetra Tech deployed a set of loggers to provide redundancy to the loggers deployed by the contractor (Rowe). Rowe deployed loggers utilizing vented cables and Tetra Tech deployed sealed loggers. A few of Rowe's loggers recorded periods that appeared to have been affected by plugging or obstruction of the cable vent. The vent tube in UFMW-1 appears to have been plugged for the entire test which resulted in higher amplitude fluctuations of recorded water levels in comparison with the water levels recorded by the Tetra Tech loggers. The vented cables showed the greatest effect during the passing of Tropical Storm Fay. This appears to have been caused by water entering the vent tubes during one or more of the strong storm events. This effect was observed in the data from Rowe's loggers for wells LFMW-2 and DZMW-1 (upper and lower zones). The water levels collected by Tetra Tech data loggers with non-vented pressure transducer cables were corrected for measured barometric pressures and the amplitude of daily fluctuations is generally less and is consistent throughout the period of observation. However, the Rowe water level data collected more early time data and proved more useful in the analyses of the four wells used to determine hydrogeologic parameters.

The hydrograph for the surficial aquifer monitor well showed no apparent response to the CRDT, but instead showed variation due to evapotranspiration, rainfall, and drainage. The uncorrected hydrograph of the UFA monitor well does not, at first inspection, appear to show much of an influence from the CRDT. Likewise, the uncorrected hydrograph of the LCU does not appear to show any effect of pumping from the overlying LFA. However, when the external influences of regional potentiometric head fluctuations, barometric pressure changes, and earth tides are removed, it is evident that drawdown in the LCU did occur. The UFA hydrograph also records the small amplitude influences of earth tides and barometric pressure changes, but regional trends are the dominant influence. Drawdown is evident, but the magnitude appears smaller than the diurnal fluctuations and much smaller than regional trends. We think that the large rise in potentiometric head during the later portion of the test and during the recovery period is a response to recharge from Tropical Storm Fay.

It is useful to compare the relative response of overlying and underlying aquifers to the response of the pumped aquifer during a CRDT. At the Cypress Lake site, UFA well UFMW-1 and LFA well DZMW-1 (lower zone) are similar distances from well TPW-1, and their hydrographs record, respectively, head in the overlying and underlying potential source beds. Well DZMW-1 (upper zone) is constructed into the production zone of well TPW-1, and consequently has a much larger response to the CRDT. If all leakage into the production zone is vertical, then the ratio of drawdown in the overlying source bed to the drawdown in the underlying source bed is a measure of the relative leakance. Neither interval appears to be hydrologically well connected to the production zone, but the UFA appears to be better connected than the ICU and lower portion of the LFA. The lower portion of the LFA does not appear to be hydrologically well connected to the upper portion of the LFA as shown in the hydrographs for DZMW-1 (lower zone), which is dominated with regional water level trends. The degree of connection between the UFA and the lower portion of the LFA with the production zone (the upper portion of the LFA) will be determined by calibrating a groundwater flow model using corrected drawdown data from the LFA CRDT.

4.2.4.2 Corrections

The water level data were analyzed for all four wells constructed in the upper portion of the LFA. The data were analyzed to remove barometric pressure fluctuations, earth tide influences, and regional trends. The phase and magnitude of each time-series was adjusted to minimize the diurnal fluctuations and the gross regional trends. Because regional trend effects may vary in locus with time, different trends were applied to the early and late field data. The data and trends were adjusted so that the drawdown at the start of the CRDT was set to 0.0 feet. Numerous scenarios were run to extract these influences from the observed data set for each observation well for the CRDT. The nearby regional wells considered for extraction of regional trends were OSF-98 and OSF-104M. The regional trends observed during the CRDT at the Cypress Lake Wellfield most closely resembled OSF-104M, and it was this well that was used to extract the regional trends from the observed data. The field data and corrected data are plotted on the potentiometric head change graphs provided in **Figure 4-3** through **Figure 4-8**. The impacts from Tropical Storm Fay caused a second regional trend to be added to the hydrograph due to recharge to the Floridan aquifer at distant recharge locations. This second regional trend was removed in order to analyze the recovery data. The corrected data were the data used to calculate the hydrogeologic parameters and is provided in **Appendix D.5**.

FIGURE 4-3
TOHOPEKALIGA WATER AUTHORITY
CYPRESS LAKE WELLFIELD EXPLORATORY TEST WELL
AQUIFER PERFORMANCE TESTING REPORT
TPW-1 POTENTIOMETRIC HEAD CHANGE

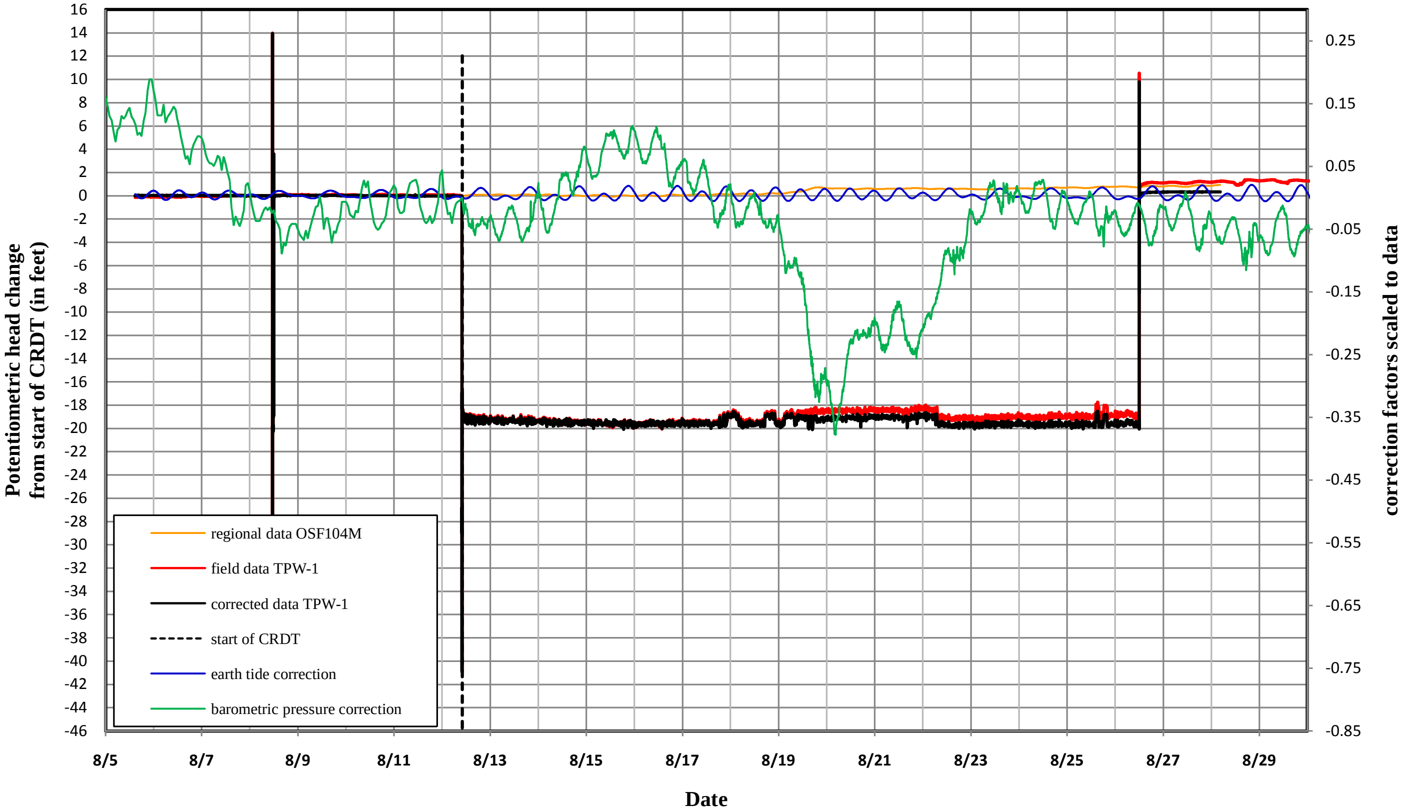


FIGURE 4-4
TOHOPEKALIGA WATER AUTHORITY
CYPRESS LAKE WELLFIELD EXPLORATORY TEST WELL
AQUIFER PERFORMANCE TESTING REPORT
DZMW-1 (UPPER ZONE) POTENTIOMETRIC HEAD CHANGE

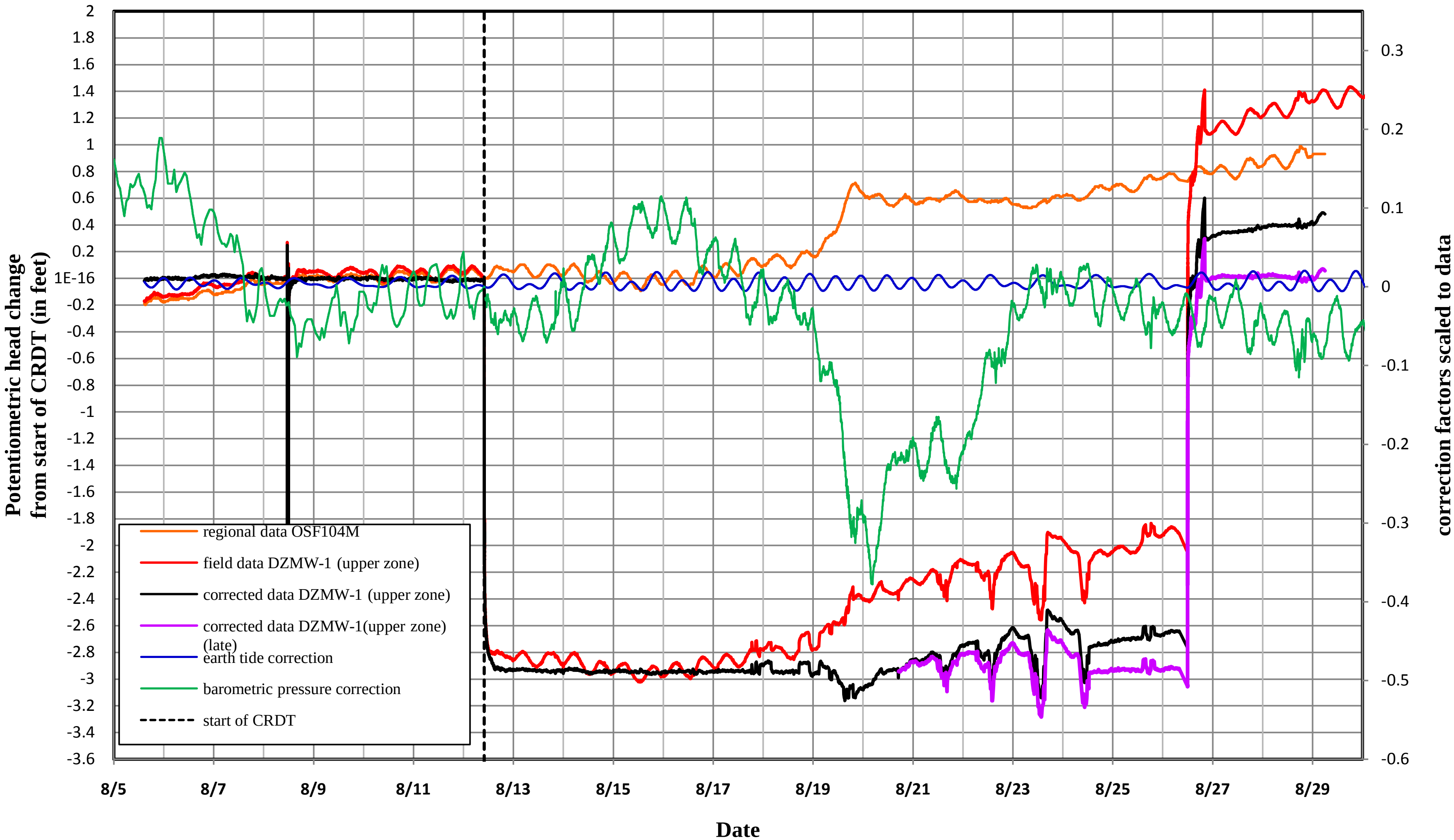


FIGURE 4-5
TOHOPEKALIGA WATER AUTHORITY
CYPRESS LAKE WELLFIELD EXPLORATORY TEST WELL
AQUIFER PERFORMANCE TESTING REPORT
LFMW-2 POTENTIOMETRIC HEAD CHANGE

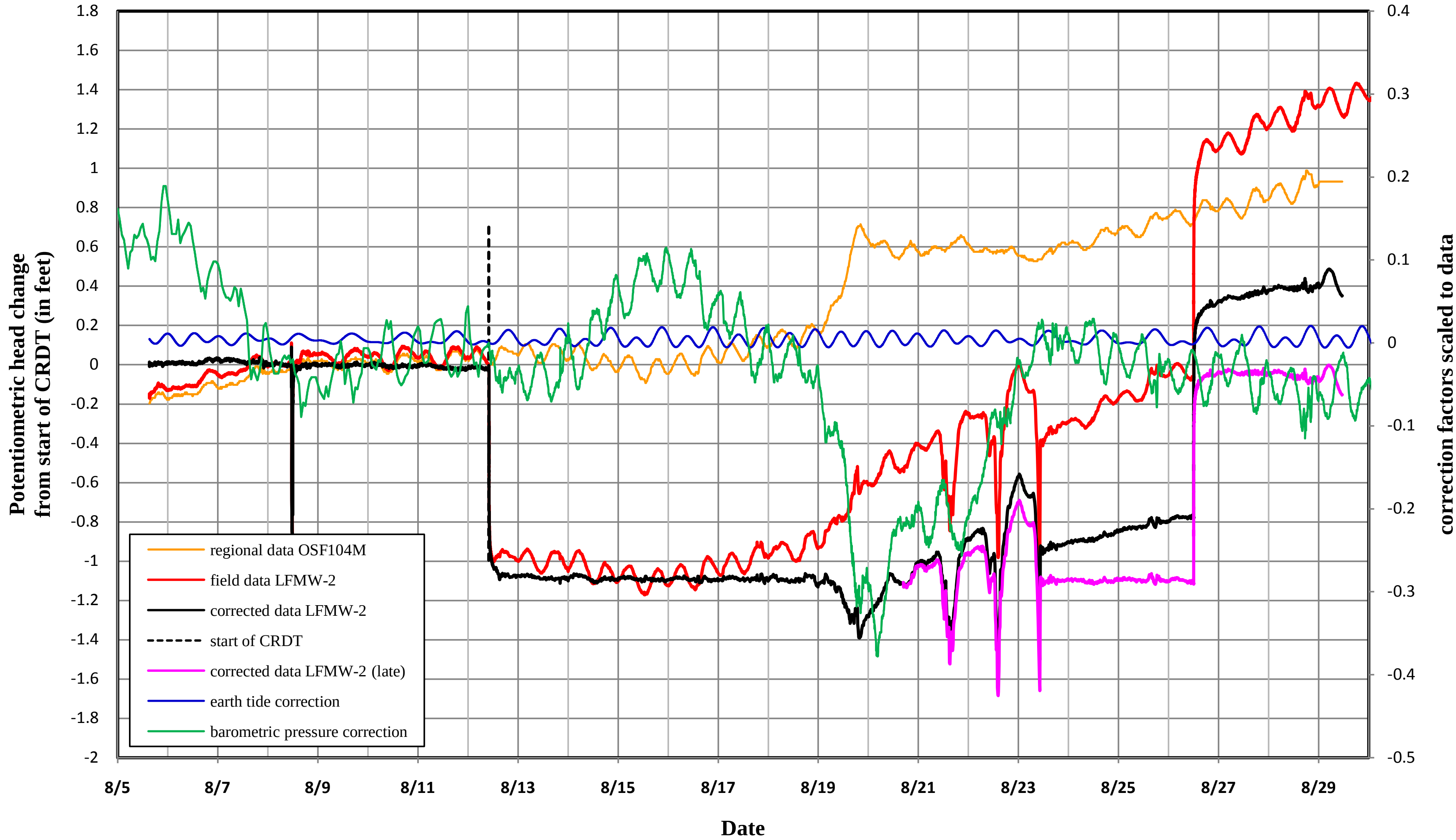


FIGURE 4-6
TOHOPEKALIGA WATER AUTHORITY
CYPRESS LAKE WELLFIELD EXPLORATORY TEST WELL
AQUIFER PERFORMANCE TESTING REPORT
LFMW-3 POTENTIOMETRIC HEAD CHANGE

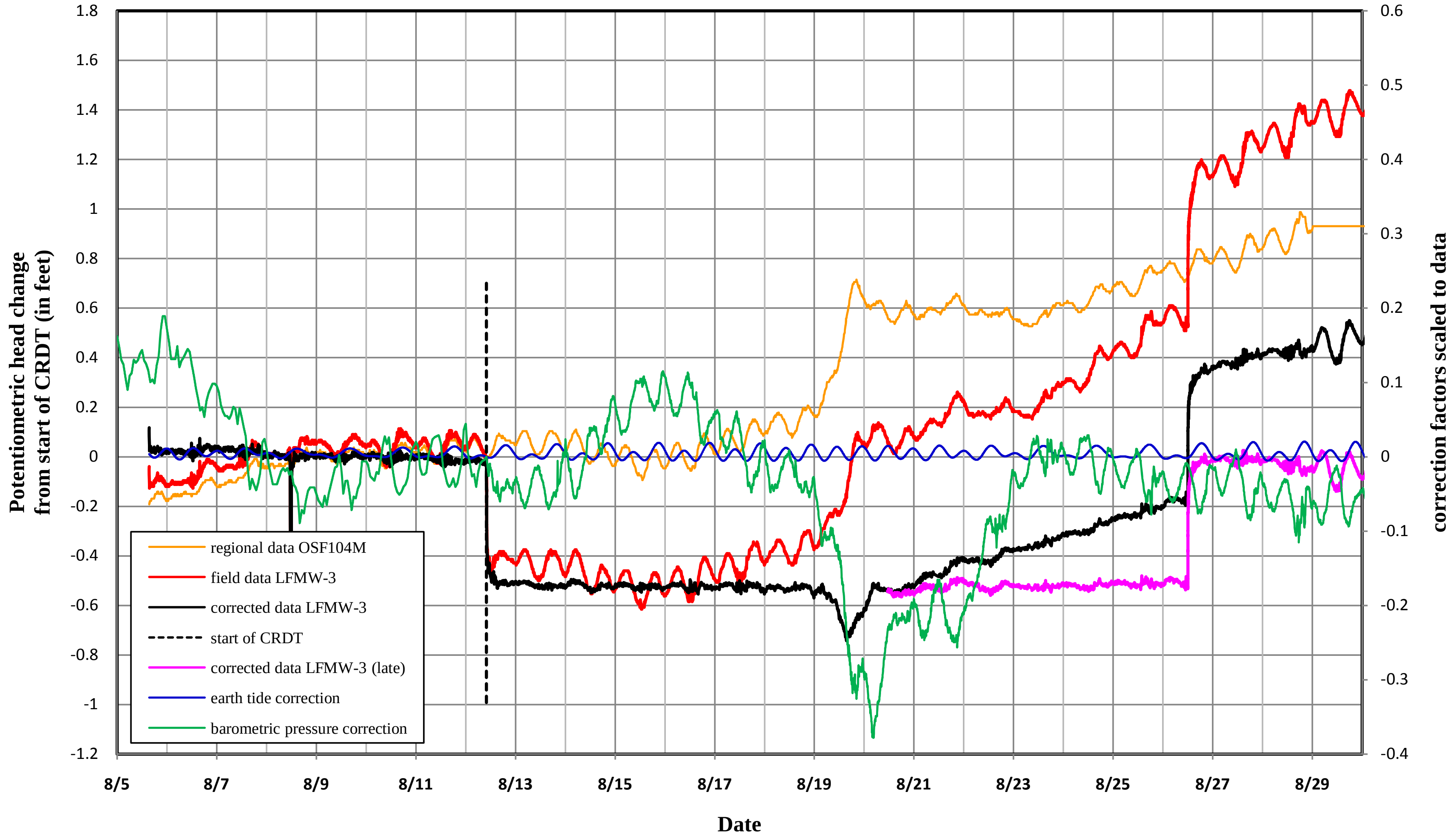


FIGURE 4-7
TOHOPEKALIGA WATER AUTHORITY
CYPRESS LAKE WELLFIELD EXPLORATORY TEST WELL
AQUIFER PERFORMANCE TESTING REPORT
UFMW-1 POTENTIOMETRIC HEAD CHANGE

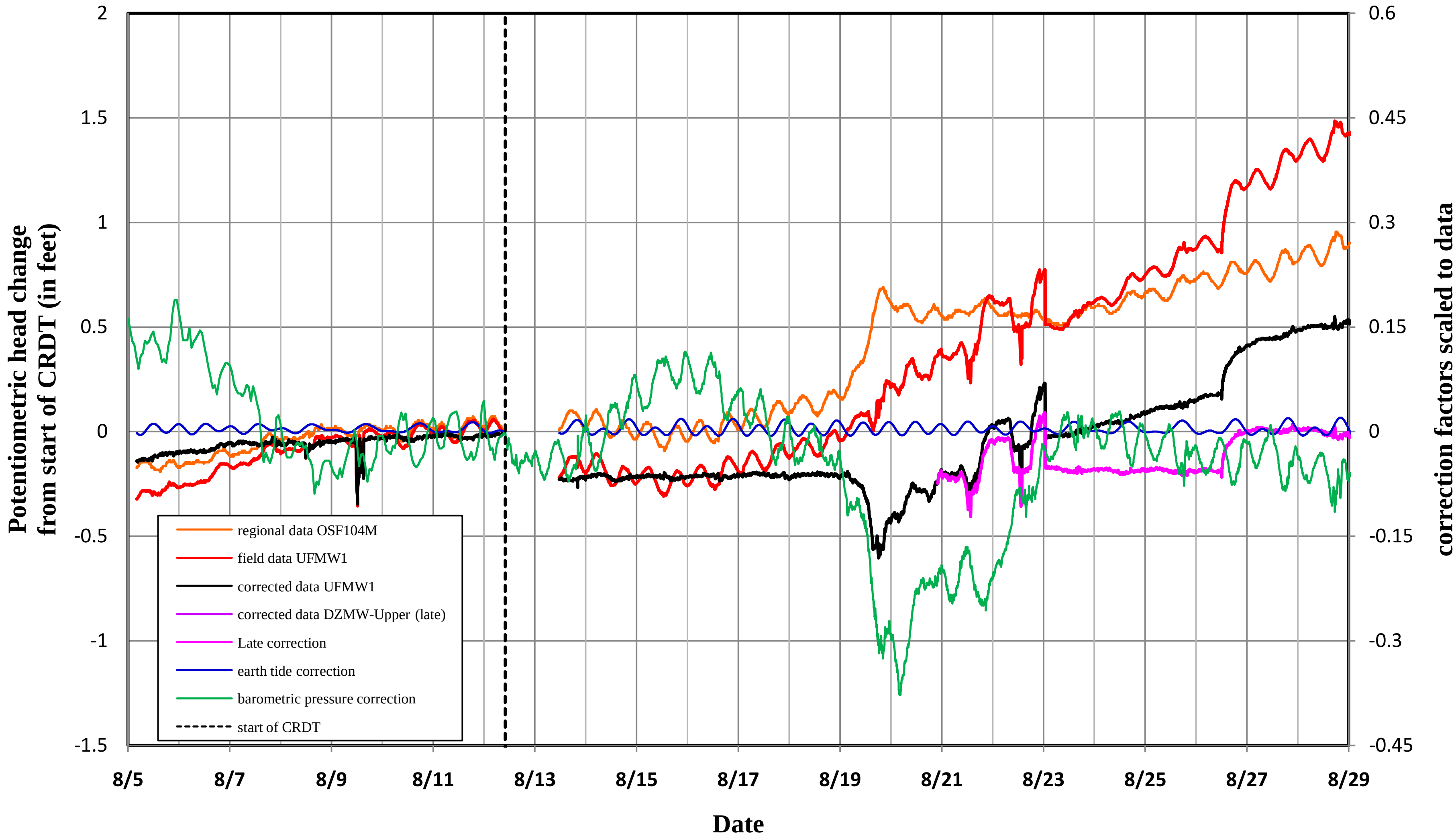
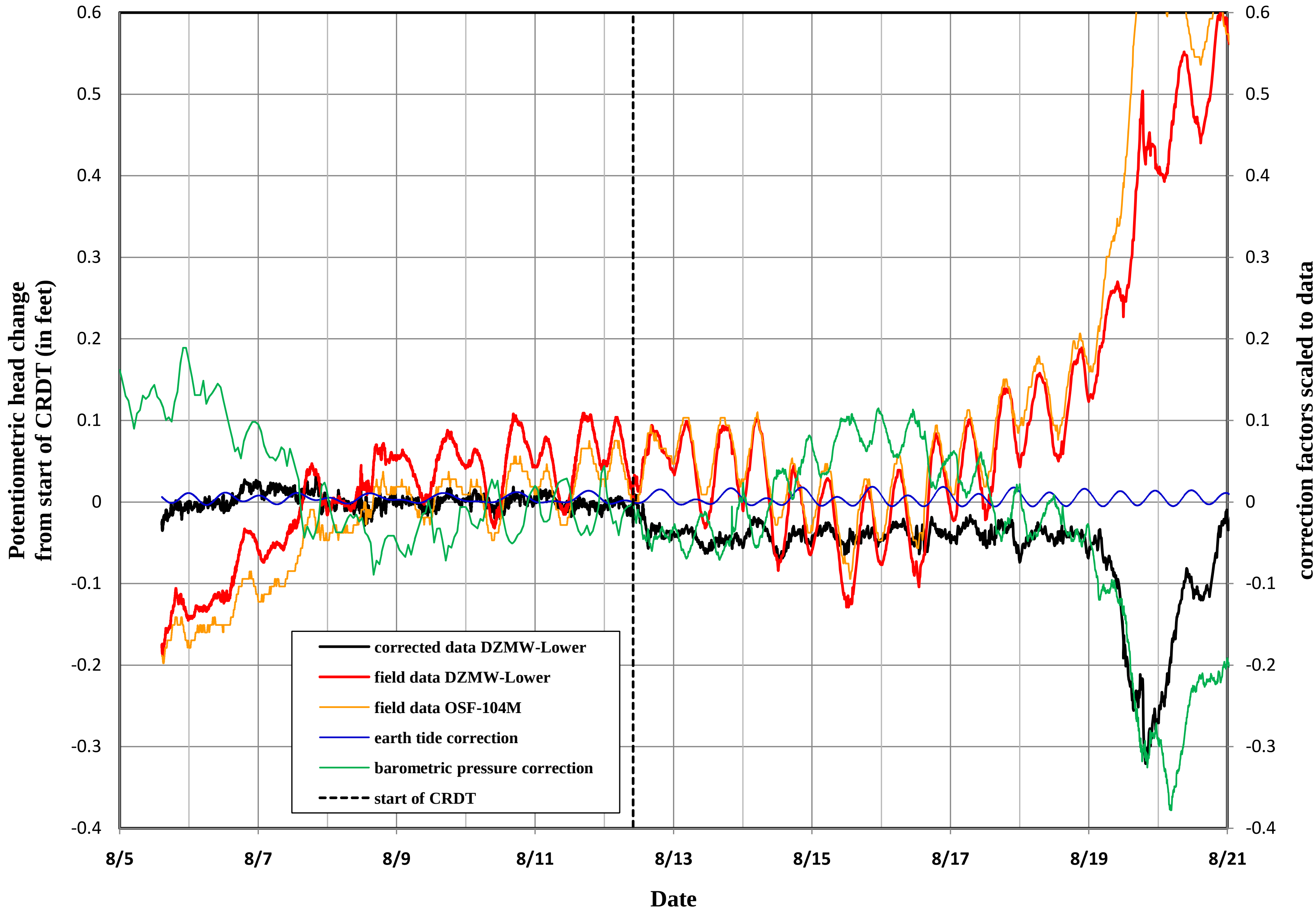


FIGURE 4-8
TOHOPEKALIGA WATER AUTHORITY
CYPRESS LAKE WELLFIELD EXPLORATORY TEST WELL
AQUIFER PERFORMANCE TESTING REPORT
DZMW-1 (LOWER ZONE) POTENTIOMETRIC HEAD CHANGE



4.2.4.3 Analytical Methods

The methods for evaluating aquifer tests in a confined aquifer have the following assumptions and conditions:

- The aquifer is confined;
- The aquifer has a seemingly infinite areal extent;
- The aquifer is homogenous, isotropic and of uniform thickness over the area influenced by the test;
- Prior to pumping, the piezometric surface is horizontal (or nearly so) over the area that will be influenced by the test;
- The aquifer is pumped at a constant discharge rate;
- The well penetrates the entire thickness of the aquifer and thus receives water by horizontal flow.

The methods for evaluating aquifer tests in a semi-confined aquifer have the following assumptions and conditions:

- The aquifer is leaky;
- The aquifer and the aquitard have a seemingly infinite areal extent;
- The aquifer and the aquitard are homogenous, isotropic and of uniform thickness over the area influenced by the test;
- Prior to pumping, the piezometric surface and water table are horizontal over the area that will be influenced by the test;
- The aquifer is pumped at a constant discharge rate;
- The well penetrates the entire thickness of the aquifer and thus receives water by horizontal flow;
- The flow in the aquitard is vertical;
- The drawdown in the un-pumped aquifer (or in the aquitard, if there is no un-pumped aquifer) is negligible (Kruseman and De Ridder, 1994).

Analytical methods used in the determination of the hydrogeologic properties include the Cooper-Jacob straight-line method, the Hantush-Jacob method, the Cooper-Jacob time-distance-drawdown method, and the Cooper-Jacob distance-drawdown method. The Cooper-Jacob straight-line method is used to determine the transmissivity and storage of a confined or semi-confined aquifer with time plotted along a logarithmic X-axis and drawdown plotted along a linear Y-axis. The earliest time data is excluded from the analysis due to well storage effects. In semi-confined aquifers the later time data is excluded when leakance of water from adjacent aquifers begins to offset drawdown and the drawdown hydrograph deviates from a straight-line response. This method can be applied to the pumping well as an observation well in an aquifer performance test to determine transmissivity, but it cannot be used to determine storage due to energy losses within the pumping well that results in the head in the aquifer being higher than the water level in the pumping well.

The Hantush-Jacob method is used to determine transmissivity, storage, and leakance values for a semi-confined aquifer with time plotted on a logarithmic X-axis and drawdown plotted along a logarithmic Y-axis. This method uses type curves developed by Walton to match to the plotted corrected drawdown. As leakance values increase in the aquifer, the drawdown curves deviate further from the Theis non-equilibrium type curve. Match points determined from the method help in the calculation of transmissivity and storage values, and the r/B value selected for the matched type curve is used in the calculation of the leakance value.

The Cooper-Jacob time-distance-drawdown method is used to determine transmissivity and storage of a confined or semi-confined aquifer with the ratio of time and radial distance squared (t/r^2) plotted along a logarithmic X-axis and drawdown plotted along a linear Y-axis. Another alternate Cooper-Jacob method used to determine transmissivity and storage of a confined or semi-confined aquifer is the distance-drawdown method. This method uses drawdown data at specific early times with distance plotted along a logarithmic X-axis and drawdown plotted along a linear Y-axis.

4.2.4.4 Calculations

The hydrogeologic parameters determined from the LFA CRDT are summarized in **Table 4-3**. The arithmetic mean or average LFA transmissivity calculated for all of the analyses were approximately 138,000 ft^2/day and the geometric mean was approximately 130,000 ft^2/day. The arithmetic mean storativity calculated for all of the analyses was 0.0007 and the geometric mean

TABLE 4-3
TOHOPEKALIGA WATER AUTHORITY
CYPRESS LAKE WELLFIELD EXPLORATORY TEST WELL
AQUIFER PERFORMANCE TESTING REPORT
HYDROGEOLOGIC PARAMETER RESULTS

Observation Well	Transmissivity (ft^2/day)	Average Transmissivity (ft^2/day)	Storage	Average Storage	Leakance (day^{-1})	Average Leakance (day^{-1})	Analysis Method	Drawdown or Recovery	Time (days)
TPW-1	127,000	127,250	---	---	---	---	Cooper-Jacob Straight Line	Drawdown	---
	127,500		---	---	---	---	Cooper-Jacob Straight Line	Recovery	---
DZMW-1 (upper zone)	99,400	100,880	0.00010	0.0001	0.000757576	0.001542	Hantush-Jacob	Drawdown	---
	100,000		0.00010		---		Cooper-Jacob Straight Line	Drawdown	---
	100,000		0.00010		---		Cooper-Jacob Time-Distance-DD	Drawdown	---
	100,000		0.00009		0.002325581		Hantush-Jacob	Recovery	---
	105,000		0.00006		---		Cooper-Jacob Straight Line	Recovery	---
LFMW-2	149,000	169,600	0.00026	0.0002	0.00625	0.003501	Hantush-Jacob	Drawdown	---
	153,000		0.00023		---		Cooper-Jacob Straight Line	Drawdown	---
	160,000		0.00022		---		Cooper-Jacob Time-Distance-DD	Drawdown	---
	221,000		0.00006		0.00075188		Hantush-Jacob	Recovery	---
	165,000		0.00016		---		Cooper-Jacob Straight Line	Recovery	---
LFMW-3	271,000	209,920	0.00034	0.0002	0.0057	0.002896	Hantush-Jacob	Drawdown	---
	283,000		0.00030		---		Cooper-Jacob Straight Line	Drawdown	---
	300,000		0.00028		---		Cooper-Jacob Time-Distance-DD	Drawdown	---
	97,800		0.000002		0.00004		Hantush-Jacob	Recovery	---
	97,800		0.000002		---		Cooper-Jacob Straight Line	Recovery	---
DZMW-1 (upper zone), LFMW-2, LFMW-3	55,846	80,949	0.00640	0.0025	---	---	Cooper-Jacob Distance Drawdown	Drawdown	0.1
	66,000		0.00088		---	---	Cooper-Jacob Distance Drawdown	Drawdown	0.01
	121,000		0.00019		---	---	Cooper-Jacob Distance Drawdown	Drawdown	0.001
Average	144,967	137,720	0.0005	0.0007	0.003	0.003			
Geometric Mean	130,973	129,906	0.0001	0.0003	0.001	0.003			

was 0.0003. The arithmetic mean leakance calculated using the Hantush-Jacob method was 0.003ft/day/ft and the geometric mean was 0.003ft/day/ft. Vertical hydraulic conductivity of the lower confining unit (LCU) was not calculated using analytical methods, but will be calculated during modeling. Drawdown in the LCU at well DZMW-1 (lower zone) stabilized at approximately 0.039 feet. The ratio of drawdown in the LCU to the drawdown in the LFA suggests that the vertical hydraulic conductivity is low.

Vertical hydraulic conductivity of the middle semi-confining unit (MSCU) was not calculated using analytical methods, but will be calculated during modeling. Drawdown in the UFA during the test was approximately 0.21 feet. The ratio of drawdown in the UFA to the drawdown in the LFA suggests that the vertical hydraulic conductivity is significantly higher than the LCU.

SECTION 5
CONCLUSION

5.1 Summary

This report documents the construction and testing results of four wells constructed into the lower Floridan aquifer and one monitor well constructed into the upper Floridan aquifer to evaluate the aquifer hydraulic properties of the lower Floridan aquifer east of Cypress Lake. It also provides documentation of a constant rate discharge test in the upper Floridan aquifer at the same location.

Overall, the testing program consisted of:

- Construction and logging of an upper Floridan aquifer observation well;
- Construction and logging of a lower Floridan aquifer test production well;
- Construction and logging of a lower Floridan aquifer exploratory well and conversion to a dual-zone monitor well completed in the lower Floridan aquifer production zone and the underlying confining unit;
- Sampling and analysis of groundwater during drilling;
- Sampling and analysis of groundwater from selected intervals during interval packer testing;
- Construction and logging of two lower Floridan aquifer production zone observation wells;
- Execution and analysis of constant rate discharge tests in the upper Floridan aquifer and in the lower Floridan aquifer;
- Construction of four surficial aquifer monitor wells.

The testing program was conducted in two phases to allow measurement of important aquifer hydraulic properties from the upper Floridan aquifer, the overlying intermediate confining unit, the underlying middle semi-confining unit or mid-Floridan confining unit, the lower Floridan aquifer, and the lower confining unit.

Tetra Tech provided construction oversight during the entire construction and testing program at the Cypress Lake site. Toho provided the majority of the funding with the assistance of the South Florida Water Management District and the cooperation of the Bronson Family who allowed access to their property for drilling and aquifer testing.

The construction and testing of the wells at the project site provided hydrogeologic data that was previously unavailable for this portion of Osceola County. The following data obtained from construction and testing of the wells at the project site consisted of the following:

- The top of the Floridan aquifer system at the Cypress Lake site is at a depth of 240 feet below land surface.

- Aquifer performance testing, lithologic, geophysical, and video logs indicate that the upper Floridan aquifer at the project site, occurring at 240 feet to 640 feet below land surface, shows good production capacity with correspondingly high values of specific capacity and transmissivity. Specific capacity values range from 108.7 to 79.71 gallons per minute per foot of drawdown (gpm/ft) with pumping rates of 1,367 to 2,767 gpm and drawdown of 12.60 to 34.71 feet, respectively.

- Transmissivity values of the upper Floridan aquifer were calculated to be between 42,044 and 67,054 ft^2/day, storativity values were calculated to be between $4x10^{-5}$ and $2.8x10^{-3}$ and leakance values to be between $2.4x10^{-3}$ and $2.9x10^{-3}$ ft/day/ft.

- The top of the middle semi-confining unit is at a depth of 640 feet below land surface.

- The top of the lower Floridan aquifer was identified through lithologic and geophysical logs at a depth of 1,020 feet below land surface, and extends to the deepest pilot hole boring at a depth of 2,602 feet below land surface (with the "boulder zone" encountered from 2,060 to 2,100 feet below land surface). Aquifer performance testing, lithologic logs, geophysical logs, and video logs indicate that the production zone of the lower Floridan aquifer at the project site (1,020 to 1,500 feet below land surface) shows very good production capacity with correspondingly high values of specific capacity and transmissivity. Specific capacity values range from 112.8 gpm/ft at 1,655 gpm to 87.8 gpm/ft at 3,073 gpm.

- At a discharge of 2,057 gpm at the new test/production well (TPW-1), drawdown was measured in observation wells at 500 and 1,000 feet away. The equilibrium drawdown values were approximately 1.09 and 0.53 feet, respectively.

- The arithmetic mean or average lower Floridan aquifer transmissivity calculated for all of the analyses is approximately 138,000 ft^2/day and the geometric mean is approximately 130,000 ft^2/day. The arithmetic mean storativity calculated for all of the analyses is 0.0007 and the geometric mean is 0.0003. The arithmetic mean leakance calculated using the Hantush-Jacob method is 0.003ft/day/ft and the geometric mean is also 0.003ft/day/ft.

- Drawdown in the lower confining unit at the dual zone monitor well stabilized at approximately 0.039 feet during the 14-day constant rate discharge test. The ratio of drawdown in the lower confining unit to the drawdown in the lower Floridan aquifer suggests that the magnitude of the vertical hydraulic conductivity of the confining beds is low.

- Based upon the results of the upper and lower Floridan aquifer testing and water quality analyses, a production rate of 3 million gallons per day per production well is feasible.

- High specific capacity and apparent yield suggest the site is suitable for investigation of an alternative water supply wellfield using a groundwater flow model.

5.2 Recommendations

Based on the results of the upper Floridan aquifer and lower Floridan aquifer specific capacity and aquifer performance testing at the above site, Tetra Tech recommends the Cypress Lake project area as a suitable source for a alternative water supply wellfield. Initial discussions with Toho have identified a preliminary wellfield area beginning at the current Cypress Lake wellfield exploratory well site extending approximately 6 miles south along Canoe Creek Road with production wells spaced approximately 0.5 miles apart. We recommend additional testing of the southern end of the proposed wellfield.

Additional interpretations of the testing data will result from simulations of the tests using a MODFLOW groundwater flow model. Those interpretations will be presented in a subsequent report that presents the results of simulations of potential impacts of an alternative water supply wellfield.

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